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New Zealand Geographer

VOLUME VIII April, 1952 NUMBER 1

MAN AND NATURE IN NEW ZEALAND*

ROBERT CUSHMAN MURPHY

NEW ZEALAND is the last large unit of land in the temperate world in which a wilderness was subjugated and settled by European man. The greater part of the process has been carried out within the past hundred years. New Zealand is also the latest area of its size to be settled by men of *any* race, for traces of Polynesian occupation apparently cover a period not longer than the past thousand years.

The eminently habitable environment of New Zealand might make these facts surprising. They are to be explained, however, by the same isolation that accounts for so much else that is strange in the endemic life, both plant and animal. The three islands make up the most isolated land of their size on the globe. The two main islands and Stewart Island extend in an irregular northeasterly-southwesterly direction for almost a thousand miles and correspond latitudinally with such northern-hemisphere stretches as those between North Carolina and Nova Scotia, Tangier and the English Channel, Yokohama and Sakhalin Island, and more or less with the combined coasts of the states of California and Oregon. Latitude alone, however, would give a poor clue to the climatic environment, because the northern localities cited are continental. New Zealand is eminently oceanic and insular; only in Central Otago, near the broad southerly end of the South Island, are quasi-continental weather sequences to be found. This is the sole part of the dominion where ponds close to sea level occasionally freeze sufficiently to permit skating. In Canterbury ponds freeze chiefly at altitudes above 2000 feet.

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* This essay is an abbreviated version of an article published under the title 'The Impact of Man upon Nature in New Zealand' published first in the *Proceedings of the American Philosophical Society*, Vol. 59, No. 6, Dec. 1951, pp. 569-582. It is reproduced here by permission of the author in order that it might be more readily available to New Zealand readers.

PHYSICAL FEATURES

New Zealand reaches southwards into the zone of circumpolar westerlies. Blowing from the comparatively warm surface of the Tasman Sea, these winds bring abundant rainfall and, since the mountain backbone runs prevailingly northeast-southwest, precipitation is heaviest on the westerly face. The effect is exhibited most diagrammatically in the South Island, where the Alps bisect the country into extraordinarily unlike parts. Rainfall is heaviest in the highlands, in many places surpassing 200 inches, but the coastal township of Hokitika receives 116 inches annually. By contrast, Christchurch, in the lee of the mountains and only ninety miles to the east, has an annual rainfall of 25.19 inches. In Otago, the complicated surface form can produce astonishing amplitudes of precipitation. Thus there are two stations fifty miles apart which, in 1940, had a *difference* of 367 inches in their respective total rainfall for the year.

The signs of climatic contrast from west to east are in many parts of the South Island extraordinarily abrupt. The traveller passes over the divide from a region of tree-ferns and the indescribably tangled undercover of mixed podocarp 'bush' into a mosaic terrain of beech woods (*Nothofagus*) and grass, the latter, at least until recently, expanding its area at the expense of the beech.

In the North Island contrasts are neither as sharp nor as extreme. Practically all of it is well-watered and the mixed forest was indigenously of wide distribution.

THE PRIMITIVE SETTING

Even before ecological disturbance was begun by Captain Cook in 1769 New Zealand was doubtless no more static than other parts of the earth. There is clear evidence, indeed, of climatic cycles and varied plant and animal successions coinciding with and following the era of glaciation.

Furthermore, occupation of the land for a millennium by even a sparse Polynesian population could not have been without effect. The pioneers from the tropics brought cultivated plants and one or two new animals. They tilled the ground and they knew the uses of fire for clearing. But racial or tribal *mores,* which seem to function so much more purposefully than systems of cause-and-effect perceived by civilised man, held destructive changes to a minimum. Like most primitive folk, the Maori were effective conservationists, whether or not the concept had for them a semantic meaning. Floristically, New Zealand had attained a climax, a term not to be understood as an ultimate state but rather as a long-enduring stage in a succession. It was in that stage when Tasman made his hit-and-run call in 1642, and when Cook landed in 1769.

Indigenous Fauna

In New Zealand the natural climax was to a marked extent the result of a negative factor, namely the absence of quadrupedal mammals. This represents a unique condition. With the exception of the Antarctic continent and a plentiful number of tiny oceanic islands, mammals have succeeded in establishing themselves at every land area other than New Zealand. Even the Galápagos and Hawaiian archipelagoes harboured several forms of native rodents. In New Zealand there were but two small species of insectivorous bats until the Maori introduced, many centuries before the coming of the whites, the peculiarly inoffensive Polynesian rat and an equally amiable, unaggressive dog, which subsisted upon fish, caterpillars, and vegetable matter. Respectively, these mammals shared none of the predacious traits of the brown rat and the Australian dingo. The Maori dog seems rarely or never to have gone feral. Both mammals promptly disappeared after they came into competition with the rats and dogs brought by Europeans.

Consider the significance of 'no mammals' throughout the prolonged evolution and establishment of a rich flora and a highly distinctive fauna. Without rodents or ungulates to nibble bark or crop grass or prune the forest understorey, all browsing and grazing pressure was left to specialised birds which developed to occupy, though only in part, such ecological niches. With no mammalian predators, birds were likewise free to become flightless, and even wingless, and yet to survive for a sufficient secular period to produce an amazing variety of large graviportal forms. Most of the moas became extinct, for reasons not yet fully comprehended, before the arrival of the first Pacific people. From such curious circumstances New Zealand may be said to have been 'preadapted' for sheep. The absence of terrestrial predators likewise enabled the tuatara (*Sphenodon*) to exist in New Zealand until the present, even though its relatives elsewhere disappeared in Cretaceous time.

Not every alteration, including even the irreversible trend toward extinction, is chargeable against man. Nearly all the forms of moa had died out in New Zealand from natural causes long before the first human being set foot upon its shores. But one or two rather small members of the order remained to be hunted out of existence perhaps as recently as the date of European invasion.

Domestic poultry derived from the red jungle fowl were the common property of Polynesian peoples, who carried them in the course of their navigation to unnumbered Pacific islands. The ancestors of the Maori may likewise have possessed these birds when they left their traditional *Hawaiki* on voyages which ended—for some of them—in New Zealand. If so, they doubtless devoured them in the canoes to fend off starvation. Reaching the new shores of a land overhung by the 'long white cloud', they brought only the Polynesian *word* for chicken, namely *moa,* which they applied to the overgrown flightless fowl they found awaiting them. They ate the flesh of *Euryapteryx,* made artifacts of its bones and water bottles of its great eggs until the last survivor of the species joined its direct and collateral ancestors. Apparently a smaller forest moa, *Megalapteryx,* lived in the South Island into the nineteenth century. If the Maori actually ate the last of one or both species, the fact represents one of the few known cases in which aboriginal man seems to have harried an animal to extinction.

THE EUROPEAN INVASION

At Dusky Sound in 1769, Captain Cook began the introduction of animals by setting ashore five geese, which were never again heard of. On later visits, in 1773 and 1777, he introduced the cabbage, turnip, potato, fowl, sheep, goat and pig. His garden plots promptly reverted to bush, and some of his domestic animals were eaten by the Maori before they could breed. The pigs seem, however, to have taken hold and to rank among the progenitors of the once vast population of wild swine which have been traditionally known as 'Captain Cookers'.

In 1772 the French explorer Crozet sowed the seeds of many fruits and vegetables at the Bay of Islands in the North Island. Hundreds of whites, including deserters from whaling vessels of many nations, inhabited the South Island during early decades of the nineteenth century. There was extensive sealing and whaling, trade in *Phormium* and timber, as well as in potatoes and pork, and disastrous depletion of many resources. The native kahikatea or white pine of New Zealand was carried in quantity to Australia even before 1800. It has not been generally realised how rapidly the remaking of the landscape proceeded, in all districts readily available for timber or mineral exploitation, agriculture or stock raising, long before the mid-nineteenth century period of official settlements that are now being celebrated in New Zealand.

The process increased in tempo after 1840 when the colonists endeavoured to reproduce the best-remembered and most-cherished features of the country that many New Zealanders still, anachronistically, call 'home'. In the 'sixties there was a great boom of acclimatisation societies, which were established in practically every town from Auckland to Bluff.

Plant Introductions

Naturalisation of plants in New Zealand proceeded at an even more rapid rate than that of animals. Early in the history of the new country the distinctive character of the native flora began to disappear from nearly all closely settled sections. What might be called a cosmopolitan type of vegetation began to take its place. This led such early scientific visitors as Darwin and Hooker to infer an intrinsic competitive superiority of Old World plants over those of the insular outlier. The case was, indeed, widely cited as an example of a struggle for existence ultimately resolved by survival of the fittest.

We now know that such a conclusion was unwarranted. European plants were superior only in being the dominants in a long-established man-made kind of terrain, to which much of New Zealand in turn was being rapidly converted. Even today when, according to G. M. Thomson, '. . . the direct, or—to a large extent—the indirect influence of man is eliminated, the native vegetation can always hold its own against the introduced'.

The zeal of the acclimatisation societies, as hindsight tells us, was expressed in a haphazard and irresponsible manner. Ecological considerations had no part in planning and the interests of the societies were, and still remain, mostly related to angling and shooting. The principal good that they may have accomplished, in the view of Thomson, has been the stocking of the nearly empty rivers and lakes of New Zealand with excellent fish. Many of the other results have been harmful or disastrous. The combination of introduced frugivorous birds, such as the European blackbird and songthrush, and introduced plants such as blackberry and briar rose, has proved a double-barrelled error because the birds are largely responsible for the enormous spread of the well-nigh ineradicable plants.

The introductions with the object of causing New Zealand to become 'like home' were followed in due course by another set of introductions for the purpose of destroying, or controlling, the first-comers. Rabbits, which did not become a serious problem until after 1870, were, for example, to be reduced to an innocuous state by weasels, stoats, ferrets and similar predators. It is hardly necessary to tell present-day naturalists of the result. The carnivores still thrive in abundance; so do the rabbits, but more so than ever. It is the native fauna of a land previously without mammals that has paid the price.

'Successes' and 'Failures'

For reasons not yet fully understood, New Zealand is truly a country in which many organisms brought from other parts of the world undergo an almost magic growth. This applies both to the individual and to populations. It is true that the inconsequential European water-cress promptly choked up streams, developing stems as thick as a man's wrist and fourteen feet in length. It is true, however incredible to a Californian, that several trees from his native state attain their largest known diameter and height in New Zealand, and that even the great sequoia ordinarily bears its first cones at a younger age than in its hearth land. The Monterey pine (*Pinus radiata*) enjoys in New Zealand a double growth, one in spring and one in autumn, and this tree sometimes attains a diameter of six feet within forty years. He who has not been in New Zealand has never seen a real blackberry patch. Under the Noxious Weeds Act of 1900, it is the duty of all citizens to destroy this plant, wherever found and at all seasons, but in the vernacular of briars it taunts, 'Try and stop me'. As a final example, it is also true that introduced trout and introduced ungulates attain record size or record antlers in New Zealand.

Attempts to introduce alien animals into New Zealand have not been without failures also. Throughout fifty years of effort, certain game fishes have never taken hold. Many migratory birds, such as the nightingale, blackcap, redbreast, sand-grouse, teal, pintail and golden plover, have been freed in vain, again and again. On the other hand, the penetration of large areas in all three islands by skylarks, yellowhammers, hedge sparrows, songthrushes, blackbirds and certain

Asiatic and Australian species has been phenomenal. The European blackbird (*Turdus merula*) is one of several that have become abundant in the wildest and most remote parts of New Zealand, including the fiords of the southwest and the outlying islands to the south of the dominion. The bird is a close relative of the American robin and investigations in the forest of Dusky and Milford Sounds and on the chilly and wet Snares Islands alike show it to be a striking example of reversion to habitat preference. It is no longer the blackbird of chimney-pots in English towns and villages, but has become again the primordial blackbird of the forested and thinly-settled England of Alfred the Great.

Methods of Dispersal

The process of taking over a new land by introduced plants and animals has been observed in extraordinarily dramatic form. Guthrie-Smith makes a good case in his *Tutira* for the hypothesis that a rapidly dispersing introduced animal does not spread creepingly from the edges of its range, but that the whole 'exploding' population tends to push forward *en masse*. After the first rapid local increase, the creatures, whether rabbits or weasels, start marching almost like lemmings and pass quite through great tracts of country, after which they may be seen there no more for a long time. The very broods of young born on the way continue the trek or migration.

According to such observations, the mode of dispersal is first to forge ahead to 'land's end'. The general populating of the whole country, or of suitable parts of it, is a subsequent result. Furthermore, in the ultimate stage the introduced creatures are not as a rule observed in anything like the vast numbers reported during the period of original push.

Space does not permit even a fractional cataloguing of the hundreds of species of introduced plants and animals that have established themselves in New Zealand, nor of the shocking effects upon the flora and indirectly upon the soil of the country. Of 130 introduced species of birds, about thirty have become established as wild creatures: of these, fifteen are from Europe, three or four from Asia, seven or more from Australia, and three from North America. Of forty-eight introduced mammals, all but four of which were intentionally carried to New Zealand, twenty-five are now truly feral, these including the descendants of such domestic mammals as pigs, horses, cattle, sheep, goats and cats, as well as a large number of truly wild species. The feral dog of an earlier day seems to have been exterminated.

Animal Pests

Of horned ungulates New Zealand has an incalculably large population. All have thriven in the new country, except the North American moose, which holds out, if at all, in only small numbers around one or two of the southwestern fiords. The others include wapiti, Virginia deer, mule deer, sambar, Japanese deer, red deer, fallow deer, chamois and Himalayan thar. The first of the chamois were a present from the late Emperor Franz Josef, and there now may be as many of these mammals in the New Zealand Alps as in Europe. In the season of 1936-1937, nearly 3000 of them were destroyed by the Department of Internal Affairs, but up to date there is, according to Wodzicki, no evidence of reduction in their range or diminution in their population.

In many areas, the various deer have devoured the undercover of the forest which developed throughout the proverbial million years in the absence of herbivorous mammals. Terrain may be seen in which no proper replacement is possible by seedling trees of the climax formation. Just as bands of toilers in New Zealand spend their lives uprooting naturalised gorse and broom, so other groups are occupied from one year's end to another in professional deer-culling. You need no licence to shoot wild ruminants in New Zealand; in fact, the government offers every encouragement to those willing to take part in the kill. Most of the animals are dropped in such rough country that their carcasses cannot be carried out. A certain proportion of the hides is recovered and, because of a demand for them abroad, as many as 101,000 have been exported within a single year.

The latest mammalian pest to assume the proportions of a serious threat, although it was first introduced as a forest fur resource as early as 1858, is the Australian phalanger (*Trichosurus*), commonly known as the opossum. Its dangerous potentialities, recognised after the turn of the century, are now reaching a crisis. It may yet prove to be the most damaging alien of them all. Heroic measures of public education and control technique will have to be long continued if anything more than temporary amelioration is to be accomplished. In fact, the only effective 'control' may be complete extirpation of the mammal.

The opossum is now eating the forest from the top down, while the goats and deer and pigs are destroying it from the bottom up. The marsupials are inconceivably abundant throughout the greater part of New Zealand. In Westland electric-power poles are sheathed with a band of galvanised iron which is necessary to prevent the opossums from accidentally short-circuiting the wires. At Lake Brunner the lumbermen kill from two to five opossums every night on the roof of the camp cottages they occupy. In the eastern part of the North Island forty opossums have been trapped on one acre in a single night; 300 on fifteen acres in one night; and 1500 on seventy-five acres within a period of two months. In 1945, according to figures supplied by the Wildlife Section of the Department of Internal Affairs, 922,088 opossum skins were taken. The figure may seem slight when compared with the 20,000,000 rabbit pelts exported in 1925. The point about both these mammals, however—as well as wallabies, deer and much else—is that they acquire 'friends' as rapidly as their numbers in any particular locality are reduced so much that their damage becomes less acutely palpable. Deerstalking then becomes an asset as a sport. The fur trade becomes a resource that New Zealand can ill afford to lose. Rabbiters must not be stripped of their livelihood! Rabbits, which have been an unmitigated curse to New Zealand and which have helped to reduce enormous tracts of beautiful tussock land to sterility, might even now be controlled with a closer approach to success if they had not bred themselves into 'big business'. This means that the once friendless pest, legally condemned by the Rabbit Nuisance Act of 1876, now enjoys a protective lobby, regardless of the ultimate welfare of the country. And all the while, rabbits and the various other mammalian populations stand ready for a renewed 'explosion' as soon as the inhibiting pressure is relaxed.

THE PROCESS OF EXTINCTION

Among causes of extinction, the most readily recognised is that of direct predation. The stoat, a mammal introduced from Europe, has been seen pursuing, capturing, and killing the flightless kiwi, which is one of the symbols of New Zealand. Swine have been observed rooting out and devouring tuataras, creatures as famed as the kiwi, at least in zoology classes. Cats gone wild have been seen to feed upon ground-nesting petrels and many kinds of land birds. The notorious tameness of most insular birds makes the indigenous New Zealand species particularly helpless against cats. Countless nests of eggs are known to be broken up by European hedgehogs. These destructive processes have been going on, indeed, ever since the white man first brought in undesirable aliens.

Even more effective, in all probability, are the indirect causes of extinction stemming from a widespread upsetting of the balance of nature. The alleged remedy for one peril becomes instead the source of unforeseen new evils and so the damage is compounded. Examples have already been given, but here is one more. In the 'fifties of the last century the Australian black swan, a beautiful creature intrinsically, was introduced at the behest of sportsmen or, as some New Zealanders allege, for the purpose of destroying the introduced watercress. The swan increased beyond all bounds, winning out in competition for food against several species of native ducks which have now become extremely rare. Meanwhile, the watercress remains.

Hundreds of thousands of New Zealand quail lived formerly on the grassy plains of Canterbury and elsewhere, subsisting throughout long seasons on the caterpillars of a snout moth of the genus *Pyralis*. Grass fires of the colonists practically eliminated this insect, whereupon the quail declined, perhaps later to become completely extirpated by coccidiosis acquired from imported poultry. Pathological micro-organisms new to New Zealand, no less than predacious mammals, may likewise have had much to do with the decline of the flightless rails known as the weka (*Gallirallus*) and the takahe (*Notornis*).

As early as 1888, a New Zealand naturalist, W. W. Smith, wrote with prophetic ecological insight:

> As many of our plants and insects are wholly dependent on each other for existence, any cause affecting the one affects the other. As the supply of insect-food lessens, some species of birds chiefly depending on it decrease according to the supply and rate of reduction. From peculiar habits in the economy of such species, they appear incapable of changing their food, habits, or environment, and ultimately become extinct.

The spectacular multiplication of European seed- and insect-eating birds, such as yellow buntings, greenfinches and skylarks, has combined with man's transformation of the ground-cover to force out the species that were there before them. The new horde of open-country birds, and of rabbits, has led to a population-burst of the native harrier, which in turn has helped to clean out the small lizards, formerly a conspicuous element in the fauna but now scarce. The harrier itself is a sort of index of the effect of human interference, as well as a shuttlecock of narrow human sentiment. It is praised and protected by sheepmen and grain growers, who object to rabbits and finches, but it is hated and persecuted by those whose tastes run rather to poultry and game. In parts of New Zealand a bounty of a shilling a head is placed upon the harrier and upon the European hedgehog (an undesirable pest). And one of the best sardonic commentaries upon the quaintness of human judgement is offered by the not infrequent sight of a harrier eating a hedgehog on the ground in a roadside paddock!

Reduction or extermination of indigenous life has run apace almost faster than the New Zealanders have been able to recognize it. No one yet knows the total number of native animals that have completely disappeared, but of the most conspicuous group, the birds, several have vanished from the world for ever since the beginning of the present century, and it is virtually certain that more will follow. By way of contrast, perhaps only one species of bird has become wholly extinct in Europe, a continent inhabited by man throughout thousands of years.

From Wilderness to Farm and Station

Approximately half of New Zealand was originally covered with evergreen forest. The other half included extensive rocky and stony wastes above timberline, mountain and alpine tussock, grassy plains running down to sea level, and large areas of fern—that is, of extraordinarily vigorous, tall, dense, almost impenetrable bracken. It was the fern, open country, rather than the forest, that first attracted permanent settlers, and in which the bulk of the population has continued to dwell between 1840, when New Zealand had two thousand Europeans, and the present time, when the whites total two millions.

The New Zealanders have converted more than half of the old forest into grassland, where good, bad, and indifferent plants (from the point of view of human economy) grow. Much of this once-forested grassland has already reverted to inferior scrub, in which the native manuka and the introduced gorse and broom play a part.

The grasslands have been grievously exploited as sheep stations, grazed over season after season, and the ravages of countless rabbits added to too-close cropping by 33,000,000 sheep. The modern pasture plants are mostly well-established exotics. The better sorts of indigenous grasses have decreased or disappeared, although it is only fair to claim that the best of the exotic pasturelands are not only excellent but are also still improving. The wholly depleted lands, as in parts of Central Otago, have become a man-made desert in which only pancakes of scabweed (*Raoulia*) prevent the last of the loose surface from being whisked away by the wind.

The historic 'crushing' of bracken, to use a local term, was accomplished by a combination of fire and temporary overstocking with sheep, as is vividly described in Guthrie-Smith's *Tutira.* The slaughter of the forest was practically uninterrupted throughout a century, reaching a devastating peak between 1880 and 1910. Primeval kauri, one of the world's most valuable pines, is now reduced to a few small reserves, and a half dozen different species of magnificent podocarps (gigantic relatives of the yew), which are inferior in size and worth only to the kauri, have been destroyed throughout much of their range. In New Zealand the shallow truism holds as in the United States: *the timber is needed.* The ultimate question, 'Will the need be less when the trees are gone?' remains unanswered.

SOIL EROSION

Down to the Sea in Slips is the title of a booklet issued by the New Zealand Soil Conservation and Rivers Control Council. Space permits only scant consideration of the subject in this summary, but one can agree with Cumberland when he claims that no large unit of land has suffered more vitiating loss of soil within a hundred years than New Zealand. Sheet, slip and gully erosion are all rampant. Subcutaneous erosion (the term is Guthrie-Smith's), due to rainfall on denuded surfaces, has caused the soil of slopes to buckle and slide on the underlying strata like melting snow on a roof. Balds and scars mar innumerable hillsides. Shingle slides spread unsightly and worthless aprons over the good earth around their bases. Rivers that were once confined as navigable channels between wooded banks have aggraded their entire valleys and have broken into a network of runnels which scatter boulders and silt over once-fertile flats. The worst of the streams are at one season muddy torrents that yellow the Pacific, interfere with production, disrupt communication, and even threaten the safety of populous cities such as Christchurch. In intervening dry periods, the wind picks up their dust to cover the country with a haze. The dominion, a land of still immature and thin-skinned soils, is bleeding dangerously. One authority in the country has written that it is doubtful whether the drastic changes brought about in hilly areas by heedless clearing, burning and overgrazing could have been equalled by the efforts of all the men and machinery employed in digging the Panama Canal.

RESTORATION

Despite all this New Zealand is still a land of surpassing beauty and of hopeful future. The two main islands retain the charm of Portugal and Switzerland, respectively, except that this southern Switzerland (the South Island) binds its Alps and its sea in closest juxtaposition. Despite its wounds and losses, New Zealand is not a grim place. But a visiting naturalist looks about with a more observant and critical eye than the average traveller, and, no doubt, than the average New Zealander. A large proportion of the population has little consciousness of the extent of change for the worse. Generations of Americans have forgotten, in the same way, that the northeastern states were once a land of wild turkeys and huge white pines.

The biologists, ecologists, geographers, economists, educators, enlightened agriculturalists, and at least a tolerable proportion of political leaders in New Zealand are fully aware of the hazards and complexities. Government departments are organised to meet them, and the press is receptive and honest. Research at the several divisions of the University of New Zealand, at the agricultural colleges, at such centres as the Cawthron Institute at Nelson, and in the laboratories of Wellington is productive and applicable. No landowner has to fight his battles singlehanded, for the collaboration of soil experts, hydrologists, engineers, foresters and other well-trained specialists is his for the asking. Free publications from a paternalistic government illumine every conceivable problem. Probably nowhere in the world are the methods of river control, pasture enrichment, rotation of crops and stock, pragmatic genetics, and the biology and chemistry of stored foods better understood than in New Zealand. It is only that the degrading forces have already had time to gain such frightening momentum, that the lag between what the few know and what all should know is so great. It is only that the timber exploiters can apparently carry on as long as trees stand, and that dredges continue to bury rich land under plateaus of pebbles because gold can still be sucked up from a hundred feet underground.

The Future: A Suggestion

The average New Zealander believes himself a resident of a grossly underpopulated country. He is informed regarding the opposite condition in Britain, but he is hardly aware of the fact that man—a relatively sparse animal in the earlier history of the earth—has rather suddenly become the most abundant of all large vertebrates and the only one that is continuously increasing its total numbers. Like most other fortunate beings, the New Zealander has few reminders that the bulk of mankind now goes hungry. Why then should he have a keen realisation of current relations between population pressure and environment in his own homeland? Nevertheless, it would be difficult to conceive a further *swift* growth of population without a concomitant decline in the standard of living. In a world undergoing a net increase of scores of millions annually, it is cheerful to contemplate a small, enlightened commonwealth that might grow slowly and thus remain capable of subsisting indefinitely upon the increment, rather than the capital, of natural resources.

As matters stand today, mainland reserves and national parks assure the preservation of at least samples of the matchless New Zealand flora, which has more than 1300 endemic species among vascular plants alone. Sanctuaries on the numerous surrounding islands may fulfil the same purpose for some of the native birds, for the tuatara, and much else. In the meantime, too, New Zealand is developing an even better agriculture in large areas now little subject to degenerative change. With butter and beef and the best of mutton at a quarter or a fifth of prices prevailing in the United States, the average New Zealander rejoices in present abundance and perhaps dreams of the future ten or fifteen million countrymen whom his arable land could never support in the comfort he himself enjoys. Today he is not only meeting the requirements of the dominion but is also gallantly and persistently shipping one thousand tons of food a day to Britain, his spiritual 'home' at the northern antipodes.

CHRISTMAS ISLAND PHOSPHATE DEPOSITS

SIR ALBERT F. ELLIS

THE YEAR 1920 may well be called a red letter one in the phosphate industry, for in that year the operations on Nauru and Ocean Island came under the joint ownership of the governments of the United Kingdom, Australia and New Zealand. Likewise 1949 may stand as a red letter year for Christmas Island in view of the change of ownership there, with the difference that New Zealand and Australia were the purchasers of the industry, the United Kingdom not taking part in the transaction. Further, whereas New Zealand holds a sixteen percent interest only in the first purchase, the latter is on a fifty-fifty basis.

The high-grade phosphate needs of both countries have been so well met from Nauru and Ocean Island down the years that it is not uncommon to hear the view expressed that the deposits there must be inexhaustible.[1] That, alas, is far from the truth. But the acquisition of the Christmas Island deposits and their addition to the resources of Nauru and Ocean Island means that for a long period Australia and New Zealand should be fairly well assured of their requirements of high-grade phosphate. Naturally the rate of annual increase in fertiliser consumption affects the position; greater food production entails a greater use of phosphate, and there can be little doubt that these two countries will be called upon to produce ever-increasing quantities of food for export overseas.

The real value of phosphate deposits to a country depends very largely on their proximity to its shores, for the material must be handled economically to bring it within the reach of all. The main expense in the c.i.f. price is the transport charges, principally steamer freights; they considerably exceed the cost of production. For this reason most of the European countries draw their supplies from the adjacent North African deposits. It follows therefore that Nauru and Ocean Island are the obvious source of supply for New Zealand and

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[1] For a description of the phosphate deposits and workings on Nauru and Ocean Island, and an assessment of their significance to New Zealand, see A. F. Ellis: 'Story of the Phosphate Discoveries and Workings', *N.Z. Journ. of Agric.*, Vol. 21, 1920, p. 297; and *idem:* 'New Zealand Farms and the "Phosphate Islands" ', *N.Z. Geographer*, Vol. 4, No. 1, April 1948, p. 55.

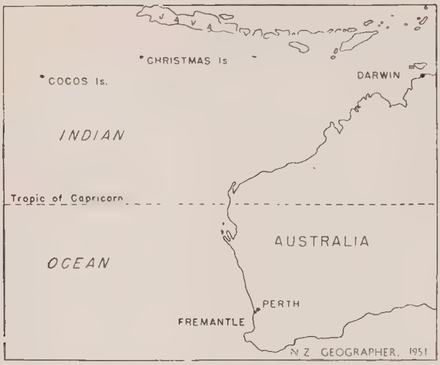
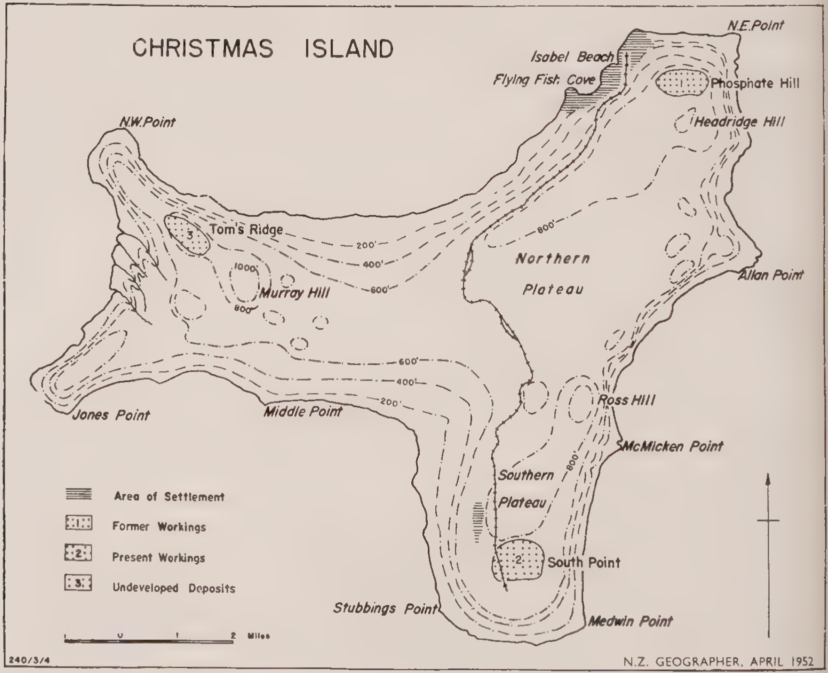


Fig. 1. Location of Christmas Island in the Indian Ocean.

Fig. 2 (below). Christmas Island, showing size, physical features, phosphate workings and settlements.

the eastern and southern states of Australia, while Christmas Island, by virtue of its proximity to Western Australia, is particularly well placed for supplying that state, whose demands for phosphate are already enormous because of the large wheat-growing areas. Under normal circumstances, therefore, no Christmas Island phosphate will come to New Zealand, but a corresponding proportion from Nauru and Ocean Island will be released for the dominion's requirements. As all Australian and New Zealand phosphate freight costs are pooled, the freight account will benefit very much by this manner of distribution.



Purchase Agreement

The success which attended the operations on Nauru and Ocean Island had long since impressed the British Phosphate Commissioners with the desirability of acquiring the Christmas Island industry, not only to increase reserves of phosphate and to arrange ocean freights to best advantage, but also to spread the risk inherent in operations of this nature. Recommendations on these lines were made to the New Zealand and Australian Governments and were duly approved. The rights to work the Christmas Island deposits were held by the Christmas Island Phosphate Company, a long-established London concern, and negotiations took place from time to time for the purchase of their interests.

In 1948 the commissioners advised the governments that the time was considered opportune for again approaching the Christmas Island Phosphate Company, and accordingly the general manager went to London duly authorised to negotiate on behalf of the New Zealand and Australian Governments. His good efforts were successful, and the phosphate lease, together with all the equipment on the island and a very useful 1900-ton steamer, was purchased as a going concern for £2,750,000.

It was further agreed by the two governments that they would set up to control the industry thus acquired an authority to be known as the Christmas Island Phosphate Commission. The British Phosphate Commission would act as its managing agents carrying on the operations on the same business lines that have proved successful with Nauru and Ocean Island. In 1949, the first year of management by the commissioners, 251,000 tons were shipped, about ten percent more than the best year under company control. This is satisfactory, but there is much yet to be done in the way of improving the equipment, and heavy expenditure must be incurred to place the industry in a really strong position.

Location, Administration and Population

The nearest land is Java about 200 miles to the northeast and the coast of Northern Australia lies about 900 miles distant (*Fig.* 1). Some 00 miles to the northwest is the large atoll group, Cocos Keeling, one of which is historical as the site of the naval battle in the first world war between H.M.A.S. *Sydney* and the German warship *Emden*, as a result of which the latter was sunk.

Christmas Island is under the administration of the Singapore Government, and a Resident District Officer with a small force of Indian police is responsible for maintaining law and order. The white staff employed in the phosphate industry numbered about twenty early in 1949, nearly all of them having their wives and families with them. The Asiatic population consists of Chinese and Malays, about 600 of whom are employed in the phosphate workings. Many of these people have their wives and children with them too, so that the total population numbers about 1300. The inhabitants have various local interests and there is ample scope for increasing these in view of the size of the island and the absence of any indigenous inhabitants. There are about 400 children, many of whom attend school and will probably be engaged in the local industry as they grow up. It was evident that the little community is well-behaved, law-abiding and healthy. A scheme for replacement of the older quarters by new ones is well in hand. Accommodation for the white staff is excellent. Amenities are good and much has been done for the comfort of the Europeans down the years. It was pleasing to see their pride in the island, quite as much as exists at Nauru and Ocean Island. One could not but feel that this British company had not only carried on its industry with much enterprise but that it had also built up a reputation for fair treatment of its employees, whether European or Asiatic.

ACCESS AND APPROACH

For a number of years communication with Singapore has been by the *Islander,* a fine little vessel now the property of the new control. She has sufficient accommodation for the island staff and their families and is fitted up for carrying labour, supplies and other necessary materials. On her return voyages to Singapore she carries cargoes of about 1400 tons of phosphate dust in sacks for use on the Malayan rubber plantations. Arrangements have been made for the continuation of this trade. As occasions arise the *Islander* makes trips to Fremantle and elsewhere carrying bulk phosphate and bringing back provisions, building and plant material, and livestock.

Early in 1949 the general manager and the author visited the island, spending nearly a fortnight there and having a good opportunity to become acquainted with conditions and problems. Quick travel being necessary, the party went by air from Melbourne to Perth, some 1600 miles, then by road to Fremantle, and the same night left by a phosphate vessel for the island 1400 miles distant, arriving there six days later. The return journey by a faster vessel was done in even shorter time. This ease of accessibility is a great advantage.

Each phosphate island differs in physical features and this has a bearing on the methods of working the deposits; there is no text-book to guide one in these matters. At Christmas Island there are many novel features. The method of going ashore was a surprise, in fact quite a new one in the author's island experience. There was some swell rolling in at Flying Fish Cove, where the settlement is situated, and this caused surf on the shore reef, as is always the case on phosphate islands because of the absence of an outlying reef and their consequently exposed position. At Nauru and Ocean Island small boat harbours have been excavated in the reef and passengers go ashore from the launch in comfort. At Christmas Island the harbourmaster came aboard and after he had expressed the hope that no one would be nervous, the launch was steered for the landing steps at the jetty. But there was too much swell and surf. The jib of a large crane was swung out and at just the right moment ropes were hooked on to the bow and stern of the launch which was then hoisted up, passengers and all, and swung in on the forty-foot jetty without difficulty. One of the problems at present under consideration is the construction of a suitable boat harbour.

Surface and Scenery

As phosphate islands go, Christmas Island is large, being twelve miles long and nine wide, with an area of forty-three square miles—probably five times the size of Nauru (*Fig.* 2). The coastline is exceedingly rugged, consisting of jagged limestone cliffs thirty to sixty feet high, with little beaches at intervals. Situated on the northwestern side, Flying Fish Cove, which is about 500 yards long and half moon in shape, is a most useful break in the formation and makes a good site for the settlement and shipping operations (*Fig.* 3). In from the cliffs there is a narrow flat coastal belt, beyond which the land rises in irregular terraces—evidence of the various stages of elevation of the island. The highest point is over 1000 feet above sea level and, in general, the island is much higher than any other worked previously. Except where the land has been cleared for settlement and phosphate operations the island is covered with dense tropical jungle (*Fig.* 4).

On some investigational trips it was necessary to have three Malays with long knives going ahead and clearing the way for the party Much of the scenery is very picturesque, particularly round the coast with huge masses of limestone interspersed with luxuriant vegetation Tropical fruits grow well and much more could usefully be done in the way of cultivation.

Phosphate Supplies

Naturally the phosphate deposits were of major interest and the impression formed was that the estimated reserves of about twenty-five million tons may prove to be conservative. The island is however so large and so densely covered in vegetation that there may be some minor deposits awaiting discovery. Search for these is hampered by the presence of six to eight feet of overburden which, as it covers the whole of the known deposits, no doubt overlies any yet to be found (*Fig.* 5). This overburden, reddish in colour, is actually a low-grade phosphate running to about seventy percent tricalcic phosphate, bu containing unfortunately about twenty-two percent of iron and alumina. These constituents cause complications in the manufacture of superphosphate. As this deleterious matter is not chemically combined with the phosphate it is evident that most of it can be removed by either a washing or a heat process. Experiments are being made and if proved sound economically, the available quantity of phosphate will be increased by perhaps ten million tons.

Apart from the problem of the overburden, the Christmas Island deposits do not differ materially from the better class of country on Nauru and Ocean Island. The ever-present limestone pinnacles are generally larger at Christmas Island and are therefore not so numerous whilst the phosphate runs deeper on the whole. This is all in favour of mechanical handling rather than hand labour. Nauru however has the great advantage from the point of view of reserves which are estimated at seventy-five million tons. Quality is much the same on the two larger islands, about eighty-five to eighty-six percent tricalcic phosphate, Ocean Island being the highest at eighty-seven to eighty-eight percent.

An interesting feature in the Christmas Island deposits is the pebble phosphate in pieces roughly the size of a hen's egg. Two beds of this material were examined and apparently contained many hundred of tons. Obviously the lumps had been rounded off by swirling in the surf at an early stage of the island's history and were later banked up like coral shingle on the beaches today. In cuttings in the overburden numerous pieces of this water-worn rock phosphate were found and gave a clue to the origin of the overburden. Not only has the island been raised in successive stages but it must also have been submerged after the phosphate beds had accumulated. At this period it would appear that the iron and alumina impurities were swept in, perhaps by ocean currents setting from the direction of the adjacent high mountainous islands, the material thus becoming mixed in the phosphate to the depth of six to eight feet. Below this depth the original deposit was undisturbed, and the iron and alumina content there remains normal. It is significant that the Nauru and Ocean Island deposits also contain this pebble phosphate with its evidence of submersion but those islands, located in mid-ocean and far removed from any source of iron and alumina contamination, were later elevated with a minimum percentage of these impurities.

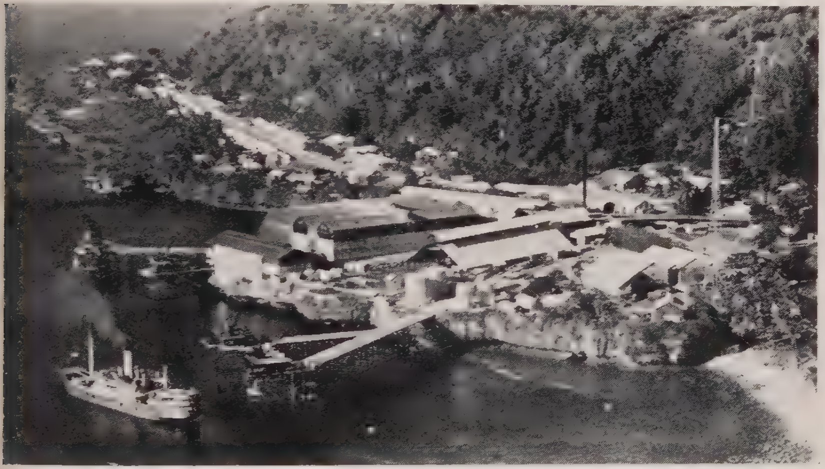


Fig. 3. Flying Fish Cove. Vessels haul under the two leading piers extending seaward from the huge storage bins, from which phosphate is taken to vessels by rubber conveyor belts. Labourers' quarters extend along the railway line. Cliffs in the foreground are of coral limestone.

The operations of quarrying the phosphate at South Point, where the main deposits are located, were of particular interest, modern mechanical equipment being used to good advantage. An area of many acres had been cleared of jungle and overburden by means of bulldozers and carryalls, ideal machinery for this preliminary operation. To dig out the phosphate, drag buckets and grabs operated by cranes and diesel engines were in use; they rapidly loaded the motor lorries which converged at a railway siding where their loads were dumped into twenty-five-ton side-delivery waggons running on a standard gauge railway line (*Fig.* 6). These were taken by diesel locomotives twelve miles to the edge of a steep downgrade where the waggons were lowered two at a time to the coastal railway connecting with the crushing, drying and storage plant. All the transpor equipment appeared to be working well and suitable for local conditions except that the steep incline down to the coast constitutes a bottleneck which makes any material increase of phosphate traffic very difficult. This problem is being considered by the engineers o the commission.

The arrangements for treating the wet phosphate delivered at the crushing plant, the driers and the storage bins are good on the whole, but will be improved in due course, as will also the power-house plant and other equipment at the settlement. Development at Nauru has been much more extensive down the years and the experience gained there will be put to good use at Christmas Island, especially since members of the present management have all served at Nauru.

Arrangements for shipping phosphate at Flying Fish Cove consis of a mechanical loading plant of two steel arms supporting rubber belt conveyors and extending from the edge of the cliff, the phosphate being delivered into the forward and after holds of vessels. The arms are unfortunately too short and necessitate the hauling of vessel so close inshore that they can be loaded only when there is no swell otherwise they are in danger. On the occasion of this visit the vessel by which the party was to return had to remain offshore for days owing to a moderate swell setting into the cove; similar weather and sea conditions would have been considered quite favourable for loading at Nauru and Ocean Island. When patience was abou exhausted the swell went down sufficiently to haul the vessel in. She was loaded and left for Fremantle the same night. Such delays to shipping are costly, but the engineers of the commission are confident that improved loading and discharging equipment can be designed to load ships moored further offshore. Flying Fish Cove has greater natural advantages than the other two islands and the depth of water offshore is much less, so that the difficulties of laying and maintaining deep-sea moorings will be minimised.

Typical jungle growth. When this is cleared, the phosphatic overburden is stripped off by bulldozers and carryalls.

Section of the phosphate workings. The overburden removed, the phos-
hate is excavated by
nechanical equipment
nd delivered to trucks.

ailway from workings
o settlement. From the
rucks the phosphate is
ransferred to railway
vaggons hauled by a
liesel locomotive.

Main office and labora-
ory building. Comfort-
ble quarters and well-
esigned buildings are
haracteristic.

SOURCE OF DEPOSITS

Soundings in the vicinity of Christmas Island show that it is a submarine mountain rising from the ocean floor more than 15,000 feet below. It has a flat summit about 1000 feet above sea level and is an upraised coral atoll on a basalt base, probably a volcanic peak. In a few places this underlying basalt is visible; all other rock is limestone or phosphate. The theory is that the phosphate deposits accumulated before the first elevation of the atoll; their origin is attributed to ancient beds of guano overlying areas of limestone and gradually effecting a change in the latter, the carbonate being replaced by phosphate. Comparing the deposits with those of Nauru and Ocean Island, it is noticeable that on the latter island there are masses of coral, sometimes weighing several tons, in which this conversion process is complete and the actual structure of the coral unaffected. It becomes lighter after the change and the colour alters from white to creamy or brown. Such 'converted coral', as it is termed, runs to about eighty-five percent tricalcic phosphate. None of this formation was seen in the present workings at Christmas Island. It has been stated that during the deep-sea dredging operations of H.M.S. *Challenger* not far from the island, nodules of phosphate rock were brought up in which phosphate had replaced carbonate. This could perhaps be considered evidence supporting the theory that the phosphate deposits have a marine origin.

FAUNA AND FLORA

Apart from matters pertaining to phosphate there are many features of interest on this beautiful and attractive island. Fortunately naturalists have dealt with this[2], but even to the casual observer there is much of interest.

The seabirds are much the same as are found in the central Pacific, but they live for the most part under different conditions, presumably through force of circumstances. For instance, frigate birds (*Fregata andrewsi* and *F. m. minor*) are comparatively scarce in the Pacific and are able to obtain their food in piratical fashion by robbing the numerous boobies (*Sula leucogaster plotus, S. sula rubripes, S. abbotti*) and other seabirds of their fish, making them disgorge in midair. Then the pirate bird quickly catches the fish before they reach the water. At Christmas Island the frigate birds are in thousands, outnumbering the boobies and others on which they normally prey. Consequently they have to adopt other measures of feeding and may be seen swooping down and greedily picking up scraps of offal after the rubbish lorry has dumped its daily load over the cliffs. Sometimes they catch fish on the surface, but not being webfooted they are at a disadvantage, particularly as their wing spread of about six to seven feet makes it difficult for them to rise from the surface of the water—indeed they cannot rise at all on a calm day. It appears that these birds, so masterful and lordly in the central Pacific, have a thin time at Christmas Island. Yet it was most surprising to see them and flying foxes soaring about in the same vicinity and in broad daylight as if they were on friendly terms.

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[2] See C. W. Andrews: *A Monograph of Christmas Island,* and G. A. Gibson-Hill, *et al.*: 'Papers relating to the Fauna of Christmas Island', *Raffles Museum Bulletin No. 18,* Singapore, 1947.

The noddy (*Anous stolidus pileatus*), an attractive species of brown tern with a white crest, lives under conditions quite different from those seen on other islands, avoiding the trees and making its nest along the face of the rugged coastal cliffs. Possibly these birds have taken to this locality to escape the attacks of the goshawks (*Accipter fasciatus natalis*) which are all too numerous.

The red-tailed bos'un or tropic bird (*Phaethon rubricauda westralis*) is fairly numerous on Christmas Island, but pride of place must be given to the unique golden bos'un (*P. lepturus fulvus*) which is found resting there, but nowhere else in the wide world. It is somewhat smaller than the red-tailed species but is a beautiful bird with its apricot-coloured plumage, and the white residents are justly proud of it. Very wisely the seabird life is protected by ordinance.

Crabs and Land Birds

Christmas Island also has a number of land birds indigenous to the island, one of them the little white-eye (*Zosterops natalis*) being pleasantly familiar as it is identical in appearance and habits with the New Zealand white-eye. A small species of thrush (*Turdus javanicus erythropleurus*) with typical thrush actions appears to be quite numerous but singularly out of place on a tropical island. Two fine species of pigeons (*Ducula rosacea whartoni* and *Chalcophaps indica natalis*) provide game birds, and shooting of these is permissible except in the recognised close season. Because of the comparative proximity of Christmas Island to Java and larger islands it is natural that there should also be frequent birds of passage. Observing these, and in other ways, anyone with a love of nature can find plenty of interest for leisure hours.

The land crabs of Christmas Island are justly famous among naturalists. On the islands of the central Pacific they are plentiful enough but the author saw more during his short visit than he had seen in all the years previously. The principal one is a brilliant red crab with black and white markings (*Gecarcoidea humei natalis*), its size being somewhat larger than a man's fist—quite a handsome specimen! Wherever one goes about the island this crab may be found, the burrows often being within a yard or so of each other. At the entrance the occupant, either male or female, is usually stationed, alert and observant. One could not but wonder as to what sort of gatherings took place after dark when they presumably roam round for their food, which consists of the partly decomposed leaves of the trees overhead. The great event of their lives however is the annual migration to the sea coast about the same time each year. En masse in hundreds of thousands they set out by the nearest route. The residents say that at such times they avoid motoring along the roads as so many are killed by the traffic that the stench is offensive. The females deposit their eggs in the sea and then all return to the interior of the island. When the young crabs hatch out they make for the shore and stream inland in countless millions. It is said that the ground is covered with them and resembles a brilliant red carpet on the move. By dint of numbers they swarm over obstacles, and in due course disperse throughout the jungle to live their lives.

Naturally one wonders if any use can be made of this superabundant crab life. Returning to the settlement one evening, the party met some Chinese heavily laden with sacks on their backs. An enquiry of the manager as to the contents brought the reply, 'Crabs! They boil them for their fowls—makes the hens lay like anything!'

There are other species of land crabs though much fewer in number. The most impressive is the great robber crab (*Birgus latro*) or, as it is usually called in the Pacific, the coconut crab. They grow to a large size and are rather like a crayfish in shape, but with exceedingly powerful pincer claws—of which beware! A well-grown crab can husk a coconut and make a hole sufficiently large to scoop out the contents. Some of the white residents go out crab hunting at night and keep live ones in captivity for ten days or so on a coconut diet, after which they are excellent eating. It is very necessary to know how to handle them, otherwise a finger might be nipped off.

Christmas Island's Past

Most islands of any importance have some history, and Christmas Island is not lacking in this respect. Moreover there is a useful aspect to the story of phosphate discoveries by virtue of their great value to agriculture. No doubt other deposits are awaiting discovery and what took place on Christmas Island may give a lead in that direction.

Dr. Gibson-Hill states that the island was first reported by the master of a homeward-bound merchantman, who sighted it on Christmas Day 1643.[3] C. W. Andrews says it was shown on a map by Peter Goos published in Holland in 1666, in which it is called Moni.[4] The earliest written description apparently was by William Dampier, English sailor and buccaneer, who called there in March 1688 when on his second voyage round the world. After mentioning his arrival and sending two *canoas* ashore in search of wood, water and fresh food, he says:

> At noon both our canoas returned aboard, and the Carpenters brought aboard a good tree, which they afterwards made a pump with, such a one as they made at Mindanao. The other Canoa brought aboard as many Boobie and Men-of-War birds as sufficed all the ship's company, when they were boiled. They got also a sort of Land Animal somewhat resembling a large crawfish, without its great claws. These Creatures lived in holes in the dry sandy ground like Rabbits. Sir Francis Drake in his voyage round the World makes mention of such that he found at Ternati or some of the other of the Spice Islands or near them. They were very good sweet meat and so large that two of them were more than a man could eat, being almost as thick as ones Leg. Their shells were of dark brown but red when boiled. This Island is of a good height, with steep cliffs against the S. and S.W. and a Sandy Bay on the north side, but very deep water steep to the shore. The mold is blackish, the soil fat, producing large Trees of divers sorts.[5]

Evidently the sailors had come across the robber crabs and found it expedient to knock off their pincer claws as it would make for ease and safety in handling them. It is obvious that there were no native inhabitants, nor has there been mention of any in subsequent accounts; this is singular in view of the densely populated islands not far distant.

Of later exploration Andrews says:

> The first attempt at an exploration of the Island was made by the frigate *Amethyst* in 1857, from which boats crew was landed with the object of attempting to reach

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[3] Gibson-Hill: *op. cit.*, p. 6. [4] Andrews: *op. cit.* [5] Dampier's *Voyages*

the summit, but the inland cliffs proved an insuperable obstacle, and the ascent was abandoned. . . .

In 1886 the surveying vessel *Flying Fish* (Captain Maclear) was ordered to make an examination of the island. The coast was found to consist of limestone cliffs, and it was only after sailing nearly all round the island that an anchorage was found in a bay with a white shingle beach on the north coast. To this the name of Flying Fish Cove was given. . . . Since the island seemed of little value, no serious attempt at exploration was made. . . .

In the following year H.M.S. *Egeria* (Captain Pelham Aldrich) called at the island and remained about ten days. Captain Aldrich and his men cut a way to the top of the island and sent home a number of rock specimens obtained on the way. . . .[6]

ANNEXATION AND ECONOMIC DEVELOPMENT

Up to 1888 Christmas Island remained unowned and uninhabited; in June of that year it was formally annexed by H.M.S. *Imperieuse* and placed under the Straits Settlements Government.

Towards the end of 1887 the rocks collected during the visit of H.M.S. *Egeria* were submitted to Dr. (now Sir John) Murray for examination, and he detected among the specimens from the higher parts of the island some which consisted of nearly pure phosphate of lime; it is to this discovery that the island owes its further development. . . .

In February 1891 Sir John Murray and Mr. G. Clunies Ross were granted a lease of the island by the British Government and in 1895-6 Mr. Sidney Clunies Ross made explorations in the higher parts of the island resulting in the discovery of large deposits of phosphate of lime. Finally in 1897 the leaseholders sold their lease to a small company. . . .[7]

It was this company with which the general manager of the British Phosphate Commissioners negotiated in 1948 for the purchase of the phosphate rights on behalf of the New Zealand and Australian Governments.

Phosphate shipments had been commenced in 1899 with ten tons to Japan. Next year 28,000 tons were shipped, and operations continued without interruption until the second World War. As with Nauru and Ocean Island, the Japanese occupied Christmas Island, remaining there from March 1942 until August 1945. They pillaged a good deal of the plant for use elsewhere, but beyond that not a great deal of damage was done, and apparently there were no serious war crimes. Probably the most exciting event of the time was the sinking of a small Japanese vessel which was lying inshore. One of the allied submarines was credited with this action. Some thousands of tons of phosphate were shipped by the Japanese, though not so much as they had anticipated, for when the island was reoccupied the bins were found to be full, with about 40,000 tons ready for shipment. This came in very usefully to help out the depleted stocks in Western Australia. It is doubtful whether the Japanese paid the Chinese labour anything for preparing all this phosphate.

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[6] Andrews: *op. cit.*

[7] *Ibid.*

However it was obvious that the unhappy memories of the war were fading. The Union Jack flies again over Christmas Island, to the undoubted satisfaction of the somewhat mixed population, and the future is bright, not only for the islanders themselves but also for those farmers in Australia and New Zealand to whom phosphatic fertiliser means so much.

LAND UTILISATION IN METROPOLITAN DUNEDIN

A. D. TWEEDIE

METROPOLITAN DUNEDIN is at once the smallest and southernmost of the four main centres of New Zealand. In a sense these two features are closely related, for the northward drift which has characterised the population of the country during the present century has not been without its effect on Dunedin, and the commercial supremacy which the city held in the goldrush days of the 'sixties has long since been lost to the northern centres. Possession of the only harbour on the two hundred miles of coastline between Oamaru and Bluff, however, combined with historical impetus and the inertia of invested capital, has allowed Dunedin to remain the regional centre for much of that area of New Zealand south of the Waitaki River.[1]

THE SETTING

From the city centre at the head of a long inlet formed by the drowning of two head-to-head valleys and the subsequent sealing off of the southern outlet by progradation,[2] the built-up area spreads thickly over the flats of South Dunedin and climbs the anticlinal ridge of Roslyn-Mornington to spill over into the Kaikorai valley beyond. The influence of this urban complex is felt well beyond these limits, however, and its existence has a significant effect on land use over a wide area. It is this influence, created by the city, which is the common unifying force in the area here defined as Metropolitan Dunedin.

In most of its physical qualities, the landscape of Metropolitan Dunedin is merely part of a much larger unit. The humid microthermal climate and the natural vegetation of podocarp forest are but the northward extensions of conditions which are characteristic of coastal areas of southern New Zealand. In part its physiography can be associated with the much larger area which Cotton classifies

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[1] The population census of 1951 shows that Dunedin is still over three times as large as its nearest rival, Invercargill.

[2] C. A. Cotton in B. J. Garnier (Ed.): *The Face of Otago*, Dunedin, 1948.

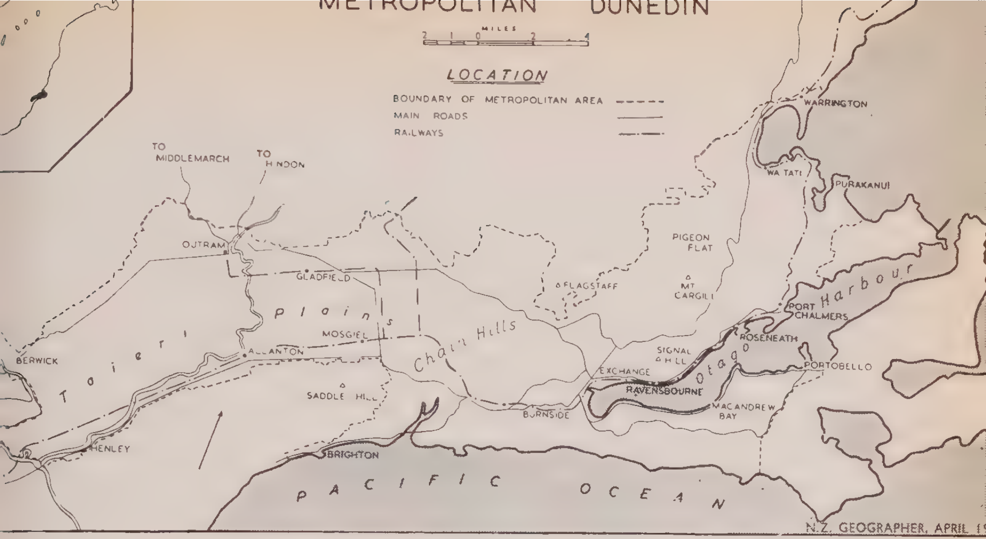

Fig. 1. Locality map and metropolitan boundaries.

as the Otago range and basin province.[3] Physical geography suggests a marked division between east and west. The contrast between the flatness of the Taieri Plain in the west and the hilly and steep slopes of the east, so evident in Figure 2, is also present in soil fertility and, to a less degree, in climate.[4] But a century of occupance has given a cultural unity to this one hundred and sixty square miles of land, and today the most significant features contributing to the geographic character of the area are the people and the use they make of the land. For, although the physical background has a contributory effect, it is the cultural imprint, as reflected in the patterns of population and land use, which give unity to the metropolitan area and distinguish it from the regions contiguous with it.

To say that population and land use give unity to the area is not, however, to suggest that these features are uniform throughout. Distribution, density and trends of population within Metropolitan Dunedin are by no means uniform, but the people therein have a common feeling of interest and may, in a broad sense, be termed 'citizens' of Dunedin. Land use (see *Fig.* 3) presents a wide variety of type and some complexity of distribution. In the main, land use is directed at fulfilling the social and economic needs of the 97,000 'citizens' of Metropolitan Dunedin. The pattern presented is at once a reflection of the physical setting, the economic demand and, to some degree, the historical background—a pattern which differs completely from the 'waving flax, the swampy solitary flats and the enveloping forest'[5] which together with the approaching winter greeted the first efforts at organised European settlement. Within this pattern of land utilisation several more or less homogeneous but distinct functional land-use units may be detected. An attempt to illustrate this regional variety has been made in Figure 4.

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[3] C. A. Cotton: 'The Geomorphic Provinces of New Zealand', *N.Z. Geographer*, Vol. 1, No. 1, April 1945, pp. 40–47.

[4] Climatological records for a short period at the Taieri airport suggest that this area is notably drier than the remainder of Metropolitan Dunedin.

The land-use regions of Metropolitan Dunedin may be grouped into seven generic types, some of which require specific subdivision. Five of these generic types have been found in the metropolitan areas of most cities of western civilisation. Two, however, are anomalous. Moreover, although the units of the urban area largely conform to the ideal type in their distribution, the units of the rural-urban fringe show an asymetric pattern which is largely a response to relief.

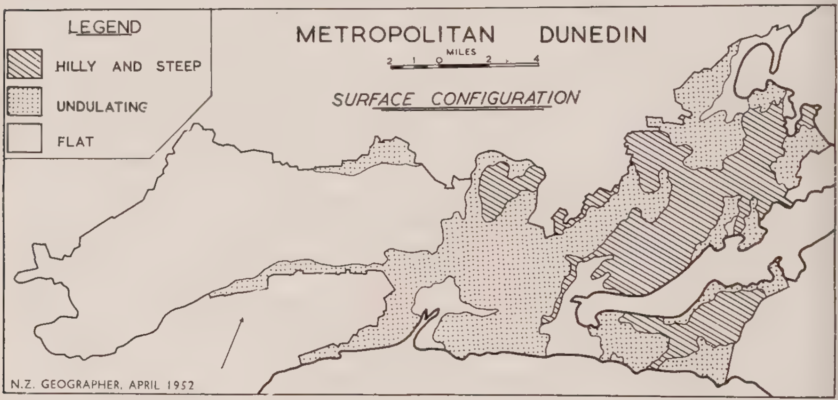

Fig. 2. Surface Configuration.

The Commercial Region of the City Core

The true heart of commercial activity in Metropolitan Dunedin is formed by the intersection of three highways at the Exchange. To this centre, the basic transport terminus for the city, has gravitated the bulk of the wholesale and retail commerce of the urban complex. It has here produced many of the customary characteristics of the 'commercial core'— high land values, tall buildings, a marked absence of vacant land and a dense concentration of pedestrian and vehicular traffic.

From the Exchange intersection, a retail commercial development dominated by services related to general merchandise, clothing, furni-

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[5] A. H. McLintock: *The History of Otago*, Dunedin, 1949, p. 148.

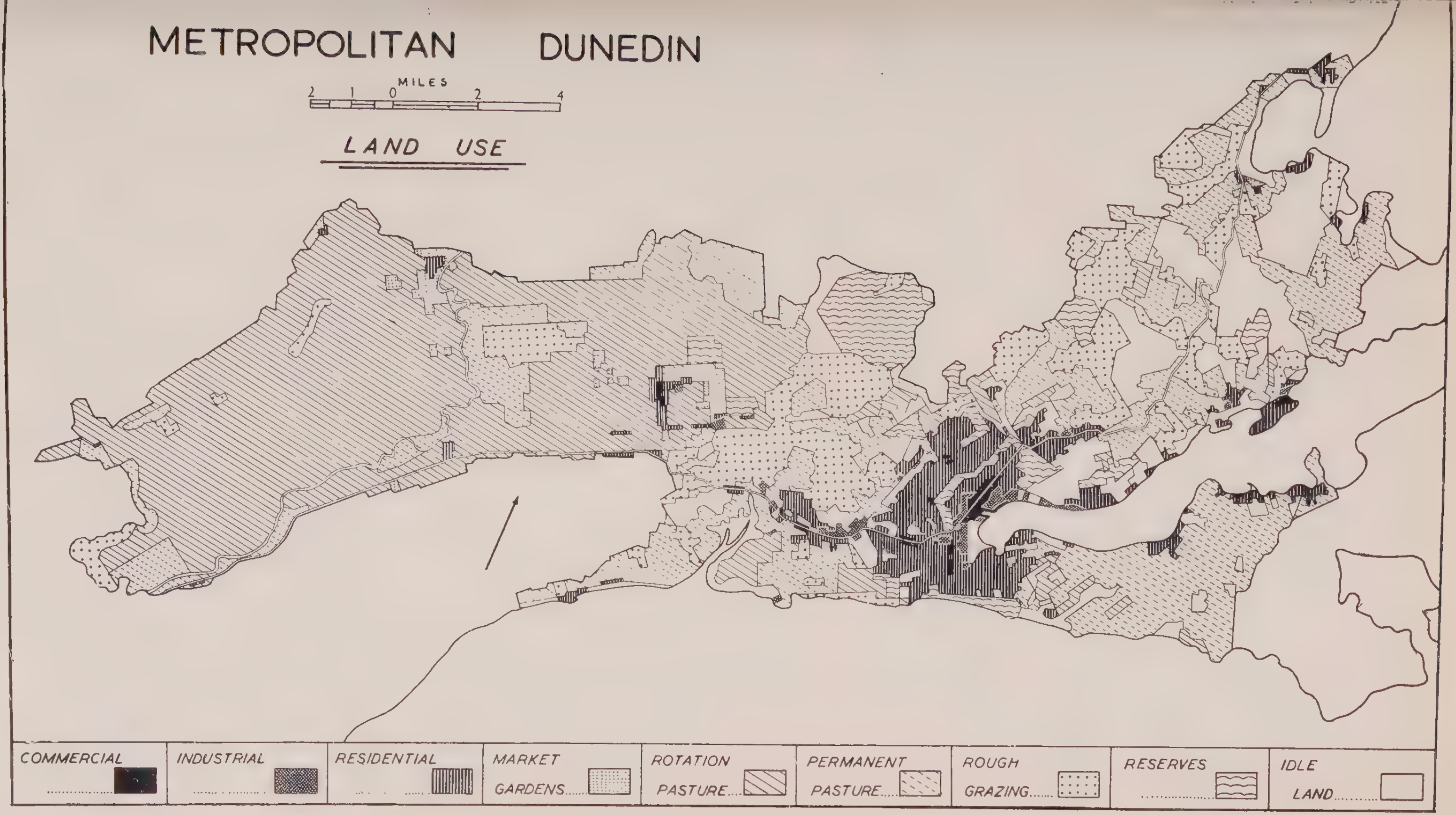

Fig. 3. Major categories of land use and their distribution.

ture and household goods stretches along the main street. Its southern development is limited in extent—a reflection of the competition provided by the subcentre of South Dunedin—but the northern extension passes the Octagon, the focal point of local government offices, and continues in a ribbon of diminishing intensity for about half a mile. The shoestring development along the main thoroughfare, and the marked absence of retail commerce in adjoining streets, are primarily a response to the heavy pedestrian traffic and potential custom using the route. It caters for the greater part of the shopping requirements of Metropolitan Dunedin. In part the layout is a reflection of historical development, itself a response to relief conditions. Steep slopes and transport difficulties prevent any great extension westwards, while the flat land to the east is largely a reclaimed area the development of which postdated the survey of the original street plan and followed the boom during which the commercial core was established.

The wholesale commercial centre of the city, based as it is on transport facilities, fills a more compact block of reclaimed land between the Exchange and the docks and railway station. It is here that the productivity of Dunedin's hinterland is reflected in the dominance of wool and grain stores which parallel the railway line for half a mile.

In terms of its function, this land-use unit of the commercial core differs only in size from the central city complex of other western cities. In details of character, however, certain features are significant. Most of the buildings, particularly those facing the Exchange, are of common age; they date from the eighth and ninth decades of the nineteenth century when the boom and mushroom development occasioned by the gold rushes in Otago was subsiding and the city held a commercial supremacy as yet unchallenged. The spirit of this Victorian prosperity and its subsequent decline has been perpetuated in stone buildings of Italian Renaissance style and the notable lack of the plaster and cement of twentieth-century architecture. The only large modern building in the area—the Central Post Office—is an indication of the increasing centralisation of government offices and official control rather than of any recent commercial progress and prosperity. Alone of the four metropolitan centres of New Zealand, Dunedin shows none of the great increases which have characterised the population of the northern centres in recent years. A significant

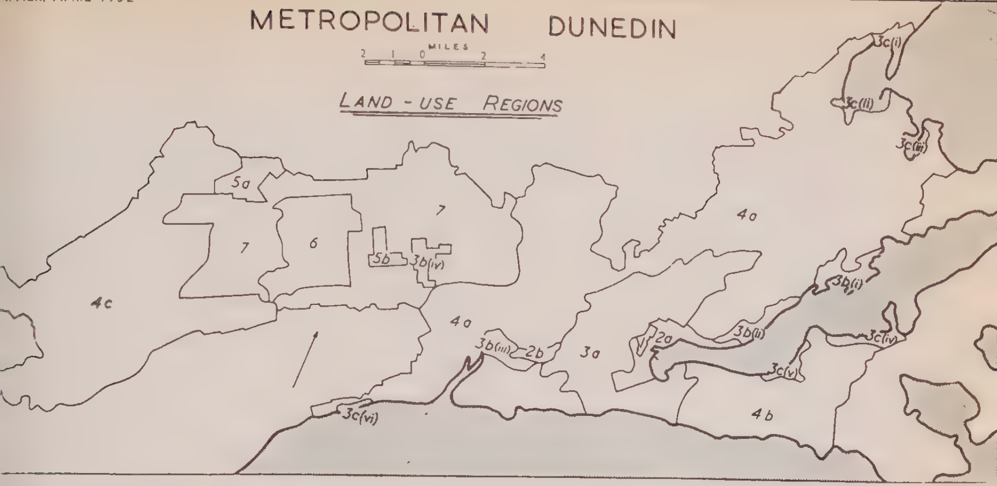

Fig. 4. Land-use Regions.

1. Commercial: City Core;
2. Industrial:
    (a) North-South Dunedin,
    (b) Burnside-Green Island;
3. Residential:
    (a) Dunedin-St. Kilda;
    (b) Industrial Dormitory Satellites,
        (i) Port Chalmers,
        (ii) Ravensbourne,
        (iii) Abbotsford-Green Island,
        (iv) Mosgiel;
    (c) Seaside Dormitory Satellites,
        (i) Warrington,
        (ii) Waitati,
        (iii) Purakanui,
        (iv) Portobello-Broad Bay,
        (v) Macandrew Bay,
        (vi) Brighton;
4. Peripheral Dairying:
    (a) Brighton-Wakari-Waitati,
    (b) Peninsula,
    (c) West Taieri;
5. Market Gardening:
    (a) Outram,
    (b) Mosgiel.
6. Beef Fattening: Gladfield;
7. Mixed Farming: North Taieri.

proportion of shops and offices have relinquished head-office status to some northern city: this emphasises the lost commercial supremacy which the architecture of the commercial core suggests.[6]

THE INDUSTRIAL REGIONS

Although historical impetus, port facilities, local transport, adequate power resources and a limited labour supply and market have combined to produce in Dunedin the leading industrial centre of southern New Zealand, industrial development here can show little of the recent and rapid progress which characterises manufacturing in Auckland.[7] Centrifugal and centripetal forces, however, have tended to create two distinct functional units associated with industrial development in the metropolitan complex.

The larger of these industrial areas, which all but encircles the commercial core, is typified by light manufacturing straddling the railway line and pushing into the blighted residential areas of North and South Dunedin. Textiles, furniture, food processing, printing, light machinery, electrical and automotive service and repair establishments combine with the breweries, whose products bulk large in Otago exports, to make up the complex of factories in this area.

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[6] The transfer of the head office of the Union Steamship Company of New Zealand from Dunedin o Wellington in 1921 was indicative of this general trend in commercial activity which was n no way halted by the artificial stimulus of the Dunedin and South Seas Exhibition of the ame decade. The changing function of some wholesale commercial buildings, in one instance rom a wool and grain store to a printing establishment, suggests an actual as well as a relative decline.

L. L. Pownall: 'Metropolitan Auckland: The Contemporary Character of a New Zealand Metropolis', *N.Z. Geographer*, Vol. 7, No. 1, April 1951, pp. 21-42.

Land use here is a more modern development than that which has given character to the commercial core, but the ability of light industry generally to use obsolete buildings does not tend to produce a modern architectural pattern. Increased demand on a limited and fully-exploited labour supply, however, is tending to foster the erection of modern factories, particularly at strategic points along transport routes and at the spearhead of the industrial infiltration into the surrounding residential areas. East of the railway, too, reclaimed land recently opened up for industrial development is leading to some modification of the character of the area. Vacant land, larger plants and industries associated with oil storage, chemical and fertiliser manufacture based on imported and bulky raw materials are evident. In general, however, the normal stamp of light industry and blighted housing cut by a well-developed road pattern serving heavy vehicular traffic gives character to the area. Recent areal expansion is associated more with a growing desire to exploit the limited labour market than with any new demands of the market or any new source of raw materials.[8] Such a move towards the labour supply, though it may modify the architecture and design of the individual factory, will merely accentuate the tendency to dispersal which is already evident.

A ribbon of manufacturing, closely associated with railway transport, has produced in the Burnside-Green Island area a second region where much of the character is the outcome of the industrial nature of land use within it. In contrast to the light industries of the city centre, however, here are all the features of a 'heavy' industrial complex. Demands for a large ground area per unit of labour, the presence of nuisance factors such as noise or waste, the bulkiness of the raw materials and the finished products and the consequent need of rail transport have produced a functional unit of distinctive character.

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[8] The newly-erected factory for Mosgiel Knitwear at the southern end of Princes Street illustrates this modern race for labour. Finding difficulties in maintaining a staff in the factory at Mosgiel, the firm has established this branch in a central city location, choosing a site at the junction of the tram services draining the heavily-populated areas of South Dunedin.

Unlike the light industrial region within the city, this peripheral development is producing no residential decline, and factories are separated by open spaces of waste land rather than by derelict houses. Tied to the railway as much by relief as by the dictates of transport demands, the complex consists of freezing, cement and chemical works, tannery, iron-rolling mill, flour mill, and box and agricultural implement factories, which stretch out along the narrow confines of the lower Kaikorai Valley. A great part of the labour requirements of this area is provided from the adjacent residential districts of Green Island and Abbotsford, but insofar as the demand is almost entirely for male employees, a surplus of female labour presents an opportunity to manufacturers and a challenge to planners.

Residential Regions

Residential land use in Metropolitan Dunedin is typical of the unplanned development of any main centre in New Zealand.[9] A central cluster of varying size and shape is set amid numerous smaller satellites which stand out in marked contrast to the dispersed pattern of rural residences throughout the remainder of the outer area. In Dunedin, conformity with this general pattern is accomplished by a more or less dense agglomeration at the head of the Otago Harbour, from which satellite settlements produce extensions in three directions.

Largest and most important of these residential units is the large region surrounding, and in parts being infiltrated by, the commercial and light industrial development of the city. Broadly speaking the whole of this area is built up. The continuous pattern is broken only by areas set aside for recreational or social services (of which the 'Green Belt' forms an easily distinguishable and notable example), or, in the outskirts, by derelict land sterilised by the threat of urban expansion. Within this area the standard of housing and the size of holdings in general varies inversely with distance from the boundaries of the industrial and commercial regions contained within it. This improvement with distance from the city centre is often reversed in the case of social services, however, and local body boundaries are often significant (as in the Waverly area) in the further development of road surfacing, public transport, sewerage and water supply. The demand of industry for flat land is modifying the normal pattern of blighted housing on the steeper slopes within the area enclosed by the 'Town Belt'. Here an unplanned slum clearance with the amalgamation of residential smallholdings (in some instances a relic of the 'tent site' holdings of goldrush days) is in progress. It contrasts with the amalgamation of holdings for the erection of factory buildings on the flats of North and South Dunedin.

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[9] See Pownall, *op. cit.*, and F. Parks: 'Land Utilisation in Metropolitan Christchurch', *N.Z Geographer,* Vol. 2, No. 2, October 1946, p. 282.

Within this residential area, the rigid rectilinear street pattern pays little tribute to the diverse relief conditions. Early attempts to force a theoretical plan upon a site where relief presented a problem to be overcome only by great skill and imagination are reflected in the numerous streets to the west of the city centre which end abruptly in a flight of steps—a feature which serves to accentuate the traffic flow in the already congested main street of the city.

The residential land use in Port Chalmers, Ravensbourne, Abbotsford, Green Island and Mosgiel owes its origin to a limited and local development of industry and commerce. With improved transport facilities, however, an increasing dormitory function can be detected. At present local industry provides employment for less than fifty percent of the employable population, in each of these residential satellites, while evidence of a declining local commercial function, suggested by the presence of empty shops points to an increased dependence on the commercial core of Metropolitan Dunedin.

Outlying Residential Areas

Problems of navigation in the upper harbour and the industry and commerce associated with shipping in Port Chalmers has given rise to an allied residential development there, which rapidly covered the accessible land in the area. The continued growth of Dunedin combined with the development of the Otago Harbour and the subsequent limitations of employment in the port has, however, produced a diurnal ebb and flow of population and enlarged the function of the area as a dormitory suburb of the main urban complex. As such, its expansion is limited (notwithstanding the modern but restricted state housing settlement in the reclaimed area of Mussel Bay) by difficulties inherent in the site. Older wooden buildings, arranged along a rectilinear street pattern regardless of relief conditions, indicate an early development of housing to conform to the original survey, and produce a residential region where age and limited expansion—if not actual decadence—give a definite character to the area.

In contrast, Mosgiel has a rectilinear street pattern eminently suited to local conditions which regulates a residential function showing every sign of recent growth. Developed originally from the presence of wool and flour mills, recent expansion in this residential area is the result of increased dormitory tendencies. A parallel decline in commercial activity within the area gives further evidence of the closer ties with the main urban complex. Despite the empty shops of the main thoroughfare, new houses and new buildings give Mosgiel an air of being a town of today—a contrast with the air of the past that pervades Port Chalmers.

The Abbotsford-Green Island complex and Ravensbourne are similar in that their development as dormitory satellites has been associated with transport facilities directed at serving areas which lie beyond them. Both show signs of recent development and a tendency to increased modernity in residences with distance from the railway station, but limitations of relief suggest that future development in the Ravensbourne area will be restricted to a lateral development along the Dunedin-Port Chalmers highway.

SEASIDE SUBURBS

The third generic subtype of residential regions in Metropolitan Dunedin are those whose origin is associated with a favourable location, but whose recent development is more the outcome of economic circumstance. The six dormitory satellites in this category—Warrington, Waitati, Purekanui, Portobello, Macandrew Bay and Brighton —are all seaside resorts where, prior to 1930, residential land use was directed at catering for the needs of a seasonal influx of holidaymakers. Cheap rents, available land for domestic gardening, and increased transport facilities, however, combined with the overall economic conditions of the depression years to change this seasonal influx to a permanent population. To a varying degree, residences in these satelites were improved or added to until the demands of permanent occupation were satisfied. Of recent years the scarcity of cheap residential building land within the city has increased the dormitory relationships of these satellites. An historical development, associated with prevailing economy, has thus produced a series of residential units f significant geographic character, in which extended and improved holiday baches are associated with and surrounded by modern bungaow residences, and line unpaved and often badly maintained streets, the pattern of which is usually an impromptu response to relief Unlike the other residential units in Metropolitan Dunedin which are contained within declared borough or city boundaries, the administration of these satellites is by county councils who are faced with the problem of providing social services for a very small part of the area they control at a cost out of all proportion to their income.

The Peripheral Dairying Regions

A major part of the rural area of Metropolitan Dunedin has a land-use economy directed at the production of fluid milk. Although with limited exceptions the whole of the metropolitan area has some interes in this economy, in three separate and distinctive areas it has stamped the landscape with a peculiar geographic personality. Certain feature associated with such production are common to all three areas.

Owner-operated farms of long-rotation English pasture grasse with a dairy herd of twenty to twenty-five cows are characteristic Varied relief conditions produce differences in the amount of farm machinery, but electrically-driven milking machines and the truck haulage of produce are common features. Milking sheds, farm house and a small implement shed make up the cluster of farm building in which the winter stalling of stock is exceptional but not unknown Individual farming practices make for little variation in the grassland economy that is practised. The attempt to produce stable and high quality exotic pastures meets with varying success, but is common to all three areas, and arable farming is limited to the production of the minimum amount of winter feed necessary to carry over milk-producing stock during the winter period of retarded grass growth

Diverse relief conditions in the Brighton-Wakari-Waitati region produce the greatest variation from the overall pattern of a dairying economy on which the land-use character of the area is based. Large stretches of third-class land, burnt-over and surface-sown with exotic pastures at an earlier period have now been reclaimed by gorse, broom and manuka and except for one area now covered by a plantation o exotic conifers, offer little economic opportunity apart from a limited amount of rough grazing for store sheep or dry cattle. Dispersed by these large neglected and retrograde areas and associated with better road and transport facilities, are patches of relatively flat or rolling country upon which dairy farming is practised. Family-operated, these

Fig. 5. Witness to the productivity of Dunedin's hinterland. Wool and grain stores of the commercial core.

Fig. 6. Light industry and 'blighted' housing give character to the central industrial area.

Fig. 7. The Green Island industrial complex—open spaces separating factory units and a close association with rail transport.

Fig. 8. The attempt to force a rigid rectilinear street pattern on relief conditions ill-suited to it has resulted in transport problems.

farms are located on well-divided and in general well-watered land.[10] Farm buildings, sheltered by tall macrocarpa and eucalypts, testify to the age of settlement.

With isolated exceptions, however, the air of reversion and retrogression which prevails throughout the region, has not failed to stamp its imprint on such activity. Shelterbelts and gorse hedges are often untrimmed, wire fences are neglected and weed control, particularly on the steeper slopes, is not always successful. The urban complex which creates the demand for this dairying economy at the same time has produced a blighting effect not only on farm labour supplies, but also on the character of farming practices of the area. In part, such a character is the result of improved transport and enhanced competition on a limited market by areas more suited to dairying than is this area of third-class land—competition made even more fatal by the rising land values and local body rates as the urban periphery spreads.

The dairying economy practised on that part of the Otago Peninsula within the metropolitan area is an old development which, in common with the Brighton-Wakari-Waitati region, has passed its peak and is now contracting in area and importance. The amalgamation of holdings, in the first instance of small subsistence farms to provide dairying units for a new economy, has been characteristic of the area for a long period. Today, however, amalgamation is related to a change to a sheep-farming economy.

Exotic grasses are maintained on the sunnier slopes of the area by semi-scientific grazing practices and a limited application of artificial fertiliser. Slopes tend to restrict any systematic rotation of the fodder crops which are restricted to the more fertile lower slopes. The attempt to establish an intensive economy of small holdings and exotic permanent pastures on third-class land of low fertility, where surface water for stock is limited, has in general resulted in the depletion of soil fertility, in the encroachment of inferior grasses and in several instances has occasioned obvious mass movement of soil. Reversion tendencies may also be traced in the gradual but definite decline in the size of the cultivated area, and in the continued encroachments of second growth and weeds. In contrast to the Brighton-Wakari-Waitati dairying region land utilisation on the Otago Peninsula is not

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[10] An absence of accessible surface water adds to dairying problems in the Black Head area, and together with the opportunity offered by the proximity of the Burnside market, has promoted a limited fat-lamb production.

Fig. 9. The combination of improved holiday baches and modern bungalows gives character to the residential satellite of Macandrew Bay.

stamped by obvious reversion tendencies, but these subtle changes insinuate the feeling of a failure in the economy.

Dairying on the fertile alluvial flats of the West Taieri district has a future rather than a past. Dairy farming here is a comparatively recent development based on improved drainage techniques directed in the first instance at supplying local dairy factories, and at present, except for the limited and seasonal cheese industry at Henley, Momona and Maungatua, to the raw milk requirements of the city. The recency of its growth stamps the landscape with a character which contrasts not only with that of the other peripheral dairying areas, but also with that of surrounding farming areas on the Taieri Plain. It is an extremely flat area of rich schist and greywacke alluvium, well served by a modified grid road pattern, where lack of relief still creates some drainage problems and where open drains and stop banks are prominent features. The lack of the possibilities of a producer-vendor economy and the almost uniform potential of relief and soil fertility has standardised farm sizes more rigidly than elsewhere.

The more recent development of this West Taieri region has produced a striking absence of mature shelter—a strong contrast to adequate hedges and shelterbelts of the north and east Taieri. Wire fences, new wooden farmsteads and milking sheds stand out in blatant fashion from an almost treeless landscape. A land with a future where the dominant activity is well suited not only to prevailing economic demands but also to the inherent qualities of the land, the West Taieri has a promise

Fig. 10. Empty shops, Mosgiel, bear witness to the changing function of the township.

of youth which contrasts with the insecure maturity of the Otago Peninsula and the decadent old age of the area embracing Brighton, Wakari and Waitati.

The Market-gardening Regions

Although the use of land for market gardening is scattered throughout Metropolitan Dunedin in areas of suitable soils or exposure, in two regions this form of land use contributes to regional character. Both these regions are on the Taieri Plain, and their siting is a response to physical conditions. The Outram region is a reflection of the better air drainage and more frost-free conditions of that area, whilst the West Mosgiel development is associated with the local soil type which warms up more readily than the remainder of those of the Taieri and so favours the production of early crops.

At Outram, market gardening has been centred on a township of older settlement and much of it is carried out by part-time gardeners in small plots surrounding dispersed houses set in a rectilinear road pattern. Income from such plots is limited and machine cultivation is restricted to contract rotary hoeing to break out the soil for the season's cropping. Surrounding this core, however, is a development based on larger holdings of ten to twenty acres. To the east and south of the township, Europeans, with machine cultivation and little labour, are responsible for market gardening based on small fruits (principally raspberries) and such field crops as rhubarb and potatoes. Machine cultivation, well-trimmed macrocarpa or brushwood fences and modern bungalows are characteristic. This contrasts strongly with the character produced by the market-gardening activities of Chinese to the west of Outram. Large and undivided holdings are here associated with a marked lack of prosperous-looking permanent fixtures. Houses are shabby and shelter limited in extent. All the effort of a large labour force is expended on the intensive cultivation of the soil by manual rather than by machine methods. The all-year-round activity and the emphasis on green vegetables of the Chinese cultivation contrasts with the winter fallow and field crops of the Europeans.

By contrast no such internal differences split the personality of the Mosgiel region. Advantages of soil type have here resulted in a recent and essentially occidental phase of market gardening in which the income is supplemented by commercial poultry farming. Ten to fifteen acre holdings worked by the owner and the part-time activity

Fig. 11. Open drains and a lack of mature shelter are prominent features of the West Taieri dairying region.

Fig. 12. 'Willow-lined roads, weed-infested pastures and a relative absence of both human and animal occupants'—the Gladfield beef-fattening region.

Fig. 13. High shelter and well-kept roads reflect the age of settlement in the north and east Taieri.

of the members of his family with relatively modern houses and well-trimmed shelter are distinctive features which isolate this region from its surroundings.

THE GLADFIELD BEEF-FATTENING REGION

From Gladfield to the Taieri River and south almost to the main railway line, is an area periodically inundated by floodwaters. Planned to act as a flood detention basin to absorb the floodwaters of the Silverstream and Taieri, it is a region of retarded settlement characterised by the lowest population density of all the land-use regions of Metropolitan Dunedin. Drainage of the region would not only be costly but would also mean the reorientation of the plans of a catchment board whose concern is for the whole Taieri Plain. The prime importance of the region as a ponding area to check the dangers of flooding to other regions has resulted in underdevelopment which is reflected in the few and widely scattered houses, the badly kept roads and fences and the extensive weed cover which produces an area of rough grazing in the midst of a region of generally stable and high quality pastures. The proximity of the Burnside saleyards and the fluctuation there of prices for beef cattle, however, has given rise to a development of some economic significance. As a fattening ground for beef cattle awaiting suitable market prices, it is, apart from exceptional instances of extensive flooding, ideal for maintaining the condition of a limited number of stock. The consequent absentee ownership and the prevailing economy of intermittent and extensive pastoralism have contributed to the air of neglect which the flood plain has produced. In the well-roaded, generally well-farmed, prosperous and dense rural settlement area of the Taieri Plain, the unkempt appearance of the willow-lined and ill-maintained roads, the weed-infested pastures and the relative absence of both human and animal occupants of the Gladfield-Riverside area presents a sharp contrast in geographic character.

THE NORTH AND EAST TAIERI MIXED-FARMING REGION

The mixed farming activity in the north and east Taieri is the outcome of the inherent quality of the land and an early development. Large holdings, taken up in the middle of the nineteenth century and subsequently influenced by the respective phases in New Zealand's agricultural history, have now been subdivided into holdings ranging from 150 to 300 acres in size. In common with mixed farming practices in New Zealand generally, the economy here is based on stock rearing, principally of dairy cows and fat lambs, in which cash cropping for wheat or small seeds is regarded as an often profitable method of supplementing a basic income. By far the greater part of each farm is laid down in long-rotation pastures of ryegrass and clover, some of which is cut for hay to supplement the limited amount of fodder crops needed for the winter feeding of a small dairy herd and a flock of breeding ewes.

Situated on the higher land of the Taieri Plain, the area enjoys all the advantages of the rich alluvial soils without any of the problems of flooding. Open drains along hedge lines are sufficient to draw off storm water while shallow wells tap plentiful artesian supplies to provide adequate water for stock. The age of the settlement is mirrored in the mature appearance of the macrocarpa and eucalypts surrounding the old wooden farmsteads and of the high gorse and hawthorn hedges which line the roads. The past system of land tenure is projected into the present character of the area through the medium of the significant proportion of leasehold property and its consequent effect on farming practices. Mature settlement and the features associated with mixed farming in New Zealand has given the area a distinctive character which sets it apart from the remainder of Metropolitan Dunedin.

CONCLUSION

The mosaic of land use in Metropolitan Dunedin can thus be reduced to a series of more or less homogeneous functional units which are a reflection of the interaction of physical, social and cultural forms and have emerged unplanned and uncontrolled from a century of occupance. These are the regions whose existence side by side help to build the geographic character of Metropolitan Dunedin. These are the regions upon the close study of which any attempt to direct future use of land in the area must be based.

THE WELLINGTON COAST : AN ESSAY IN COASTAL CLASSIFICATION*

C. A. COTTON

THE HIGH SEACLIFFS of Banks Peninsula demonstrate the primary significance of the tempo of marine erosion—working in this case at almost its slowest. To explain the high-cliffed coasts of the Wellington Peninsula, however, differential movement of the land must be postulated—a contrast to the relative stability of Banks Peninsula. Moreover, the Wellington cliffs furnish an example of marine erosion working at a fast tempo in the current cycle. Since the rate of marine erosion itself may vary, in any consideration of the origin and development of high-cliffed coasts this fact must be taken into account along with all other possibilities.

CLIFFED MOUNTAIN COASTS

Allowance being made for cliff-cutting retrogradation at its rapidest, time alone sets a limit to the height of wave-cut cliffs which may be developed along a mountainous coast.

Theoretically, the rate of cliff recession in a vastly long period of marine erosion during which the ocean level has remained fixed will become progressively slower, so that towards the end of the period the cliffs can no longer be steep.[1] Though they will still retreat, they will do so at a rate so much slower that they will be progressively degraded to gentle slopes by subaerial processes. Development and academic discussion of this purely hypothetical case of secular cliff recession have become pointless with the recognition of frequent changes of sea level in the ice ages of a not very distant past; but it is as well to keep in mind that these changes have been oscillatory—that after each glacial-age withdrawal a level somewhere near the preglacial level has been restored—though even the simplicity of this scheme is marred by an appearance as of a secular sinking of ocean level that has been long in progress and is not glacially controlled.[2]

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* This essay is a continuation of that appearing under the title 'Seacliffs of Banks Peninsula and Wellington: Some Criteria for Coastal Classification' in the *New Zealand Geographer*, Vol. VII, No. 2, October 1951, pp. 103-120.

[1] D. W. Johnson: *Shore Processes and Shoreline Development*, New York, 1919. See *Fig.* 35, p. 213.

[2] F. E. Zeuner: *Dating the Past*, London, 1950, p. 145; *idem: The Pleistocene Period*, London, 1945, p. 250.

It seems quite possible, moreover, for erosion during periods of low sea level to cut away the submarine shelf bordering a mountainous land, so that cliff-cutting may start afresh and retrogradation of the coast be reinvigorated with each successive return of the sea. Thus the cumulative effect of an integrated series of episodes of marine erosion may be the production of very high and steep seaward-facing slopes. Though these will not be strictly 'cliffs' in the present-day landscape for their full height, the basal parts, freshened by cutting renewed since the last return of the sea, will present the typical wave-undercut and steepened appearance of seacliffs. At the rear of these, the mountain slope, though it has been developed for the most part by marine erosion in earlier cycles, has since been subdued by subaerial grading; it will, moreover, be dissected.

Glaciated Shores

Though some glacially-oversteepened cliffs descend beneath sea level, becoming the plunging, precipitous walls of fiords, comparable slopes are only rarely found on outer coasts. It is possible, however, that towering seaward faces of some glaciated mountains are glacially-developed slopes which have been trimmed and perhaps further steepened by marine erosion. The nearly vertical cliffs at the North Cape of Norway (a thousand feet high) may be similar in origin to those at the rear of the 'strandflat' fringing the same coast farther south and also some other Arctic and Antarctic shores, which appear to have been steepened by a process of glacial sapping.[3] Some similar cliffs on outer coasts elsewhere are perhaps correctly placed in Shepard's category 'drowned glacial erosion coasts';[4] but in regions that have not been heavily glaciated there need be no danger of confusing any such cliffs either with slopes steepened by marine retrogradation or with those primarily of tectonic origin.

Fault Coasts

Some young fault scarps form lines of true cliffs facing the ocean;[5] but few statements that these exist have been substantiated by critical discussion of examples. Some supposed coastal fault scarps in the

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F. Nansen: 'Strandflat and Isostasy', *Vidensk. Skrifter, M-N. Kl. 1921*, Vol. 11, 1922; C. A. Cotton: *Climatic Accidents in Landscape-making*, Christchurch, 1942, pp. 195-198.

F. P. Shepard: *Submarine Geology*, New York, 1948, p. 71.

Shepard: *op. cit.*, p. 73 and *Fig.* 24C.

Hawaiian Islands[6] have been explained by Stearns and Macdonald[7] as simply lines of wave-cut cliffs.

On the island of Alinnia, in the mobile Dodecanese region, Migliorini[8] has, however, found young rectilinear fault scarps facing the sea as cliffs. These now 'plunge' as a result of drowning ascribed to local subsidence of the island, though alternatively the drowning may be eustatic (Flandrian). Plunging cliffs apparently of similar origin form the straight west sides of the islands Santa Cruz and Angel de la Guarda and the east side of Ceralbo Island, in the Gulf of California;[9] and in the case of these the sea floor slopes down steeply to a depth of five hundred fathoms only a mile and a half offshore, which indicates that the fault scarps when formed very probably descended into the sea (as true fault coasts) rather than to a land surface since submerged.

Examples of steep-to coasts are known in New Zealand (*Fig.* 2) which are either fault coasts in a first cycle or are possibly fault scarps partly submerged by rise of ocean level, being in the latter case not true fault coasts but rather such as should be classed in Johnson's category of 'fault-scarp shorelines'.[10] These are, however, for the most part within embayments formed by downfaulting or a combination of this with warping, becoming thus merely secondary features of coasts of transverse deformation.

FAULT COASTS OF AN EARLIER GENERATION

In the vicinity of Wellington (*Fig.* 1) the shores of Cook Strait, as will be discussed in a later section, afford examples of the development and persistent survival of maturity of outline adjusted to structure in a coast strongly cliffed by marine erosion. The western coast of the Wellington Peninsula truncates the grain of the terrain very obliquely (*Fig.* 3). For this coast (and for the south coast also, which cuts transversely across the same grain) a rather remote origin by offshore

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[6] T. A. Jaggar: 'Seismic Investigation of the Hawaiian Lava Column', *Bull. Seism. Soc. Am.*, Vol. 10, 1920, pp. 181-184; N. E. A. Hinds: 'The Relative Ages of Hawaiian Landscapes', *Univ. Cal. Publ., Bull. Dep. Geol. Sci.*, Vol. 20, No. 6, 1931, pp. 143-200.

[7] H. T. Stearns: 'Geology of the Hawaiian Islands', *Bull. Hawaii Div. Hydrog.*, No. 8, 1946, p. 89; H. T. Stearns and G. A. Macdonald: 'Geology and Ground-water Resources of the Island of Hawaii', *ibid.*, No. 9, 1946, pp. 42-47; H. T. Stearns: 'Geology of Molokai', in H. T. Stearns and G. A. Macdonald: 'Ground-water Resources of the Island of Molokai', *ibid.*, No. 11, 1947, p. 11.

[8] C. I. Migliorini: 'Appunti geologici sull'isola di Alinnia (Egeo)', *Boll. Soc. Geol. Ital.*, Vol. 49, 1936, pp. 57-63.

[9] F. P. Shepard: 'Submarine Topography of the Gulf of California', in 'E. W. Scripps Cruise to the Gulf of California', Part 3, *Mem. Geol. Soc. Am.*, No. 43, 1950, Pl. 1, *Figs.* 2, 3, and p. 11.

[10] D. W. Johnson: *The New England-Acadian Shoreline*, New York, 1925, p. 32.

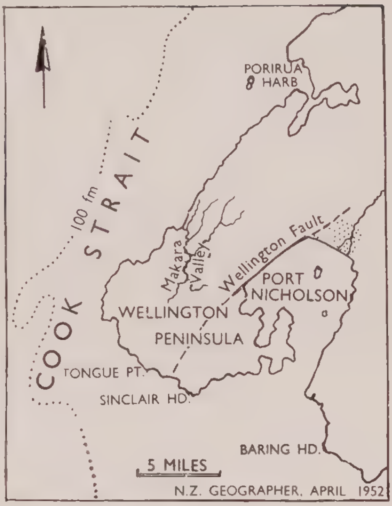

Fig. 1. Locality map of the Wellington Peninsula and adjacent coast.

faulting is probable.[11] Only the general trends of the coastal outlines can be accounted for by this explanation, however, for the shores have been cut far back by marine erosion, no doubt mainly in those epochs of the Pleistocene when ocean level has been high. Meanwhile, the land has been subject to considerable warping on axes transverse to the south coast and oblique to the west coast. Thus the coasts of today are upheaved in some parts and drowned in others. Naturally,

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[11] C. A. Cotton: 'Notes on Wellington Physiography', *Trans. & Proc. N.Z. Inst.*, Vol. 44, 1912, pp. 245-265 (see p. 254); 'Fault Coasts in New Zealand', *Geogr. Rev.*, Vol. 1, No. 1, 1916, pp. 20-47(see p. 41).

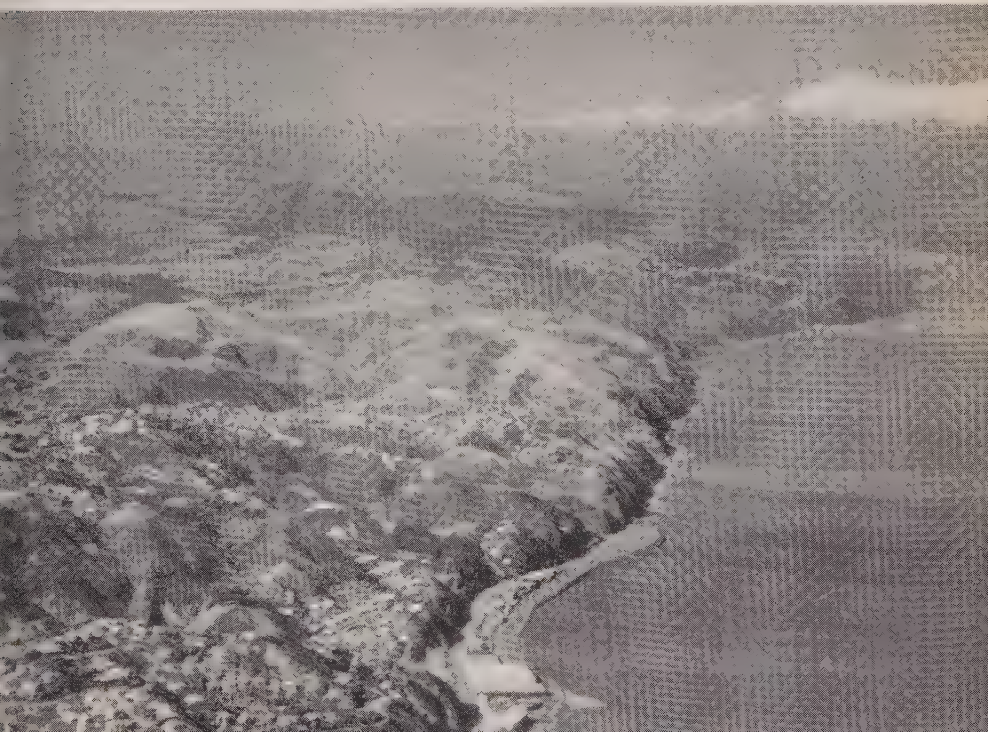

Fig. 2 (below). Scarp of the Wellington fault descending to Port Nicholson.
(*Photo: Department of Geography, Victoria University College*)

the most deeply drowned parts of the shoreline depart farthest from the assumed primitive outline.

Though the coastal fault pattern can be restored only very roughly, the non-drowned part of the west coast cuts obliquely across both the strike of the greywacke rock formations and a prevailing north-northeasterly trend of ridges and valleys in a manner which, apart from some hypothesis of offshore subsidence, could be explained only by assuming an incredible amount of marine retrogradation. Since the initial roughing out of the outline by hypothetical faults, however, erosion has been active in indistinguishable successive cycles, interrupted not only by eustatic oscillation but also by earth movements, until the existing mature but sinuous outlines have been assumed (*Fig.* 1). Headlands and bays of the sinuously-cliffed west and south coasts are due not to drowning but to prolonged activity of selective marine erosion. Minor valleys are rejuvenated and ravines on some seaward slopes are truncated by cliffs so rapidly developed that streams in them have not even begun the process of rejuvenation; some beheaded streams flow obliquely inland from crests of high cliffs. The line of intersection of freshly-cut cliffs with ridge and valley forms (*Fig.* 3) is obviously due to rapid marine erosion now in progress; but the fault scarp of a primitive coastal outline, which may be postulated as roughly parallel to that of today, quite probably intersected a generally similar landform pattern. Some of the present-day valleys, small as well as large, were very likely in existence before an initial coastal outline took form as a result of subsidence of former land to seaward—but not all of them. In this seismic region new valleys, developing from time to time on the lines of active faults which outcrop on the land surface, will disturb earlier adjustment of drainage to structure, and the relief pattern must be always changing.

Coast of Transverse Deformation

The major features of the coast at Wellington, and an association of diverse types there found, are determined by 'transverse' deformation,[12] proved in various ways in this district,[13] but shown especially by the confinement of features resulting from drowning to certain belts (compare *Fig.* 4), and by the presence and endwise tilting of marine terraces on other (adjacent) parts of the coast (*Figs.* 4, 5). The

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[12] C. A. Cotton: 'Shorelines of Transverse Deformation', *Journ. Geomorph.*, Vol. 5, 1942, pp. 45-58.
[13] C. A. Cotton: 'The Warped Land Surface on the Southeastern Side of the Port Nicholson Depression', *Trans. & Proc. N.Z. Inst.*, Vol. 53, 1921, pp. 131-143.

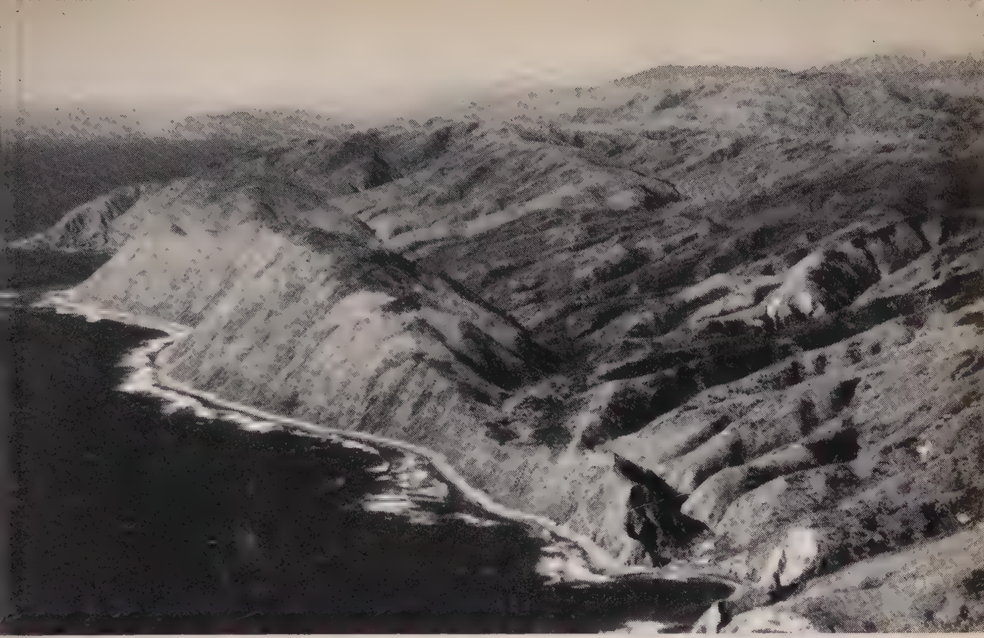

Fig. 3. West coast of the Wellington Peninsula north of the mouth of the Makara Stream showing mature, cliffed outline; beyond is the embayed entrance to the drowned segment occupied by Porirua Harbour. *Photo: Ministry of Works*)

deformation must have taken place mainly in the late Flandrian; but the question of its date will be taken up later.

Terrain and Cliffing

The terrain consists of folded and indurated greywacke strata, weakened to some extent by close-set joints, but still offering much resistance to erosion and providing the coast with a hinterland of strong mature relief, with continuous ridges rising in places to 1000 and 1500 feet.

Allowing for the generally resistant nature of the terrain, retrogradational yielding under the attack of waves is noticeably rapid on the outer, exposed parts of this coast, profiles of which are thus in strong contrast with those on sheltered interior shores in the drowned parts of the coast.

On the outer shores there are two obvious reasons for rapid cliff recession: exposure to heavy surf; and an offshore submarine profile kept steep by a combination of local circumstances, important among which is scour by tidal currents in Cook Strait. This is sufficiently strong to prevent accumulation of a built shelf. Waves break with maximum release of energy at or very near the base of the cliffs. Such, to be strictly accurate, was the condition prior to the small emergence of the southern coast due to local upheaval in 1855; but this temporary check to cliff-cutting scarcely affected the western coast.) The waves approach the shore underloaded and therefore ready for the attack. They are, moreover, 'hungry' for erosion owing to the absence of sand such as is abundant on many beach-fringed coasts, being there in transit alongshore from some more or less distant source at which it is fed into the sea by rivers. Such sand slows down erosion, or brings it to a standstill;[14] but here, owing to isolation, there is no supply of waste in appreciable amount other than that locally derived from the coast itself.

The south coast is pounded by heavy surf during frequent gales from the south and southwest. The west coast, though sheltered in parts from southerly seas, is exposed to others raised by gales funnelling through Cook Strait from the northwest. This coast is continuously cliffed, even around the heads of bays (*Fig.* 3), but the cliffs are lower in general than those of the south coast (*Fig.* 3 in the first part of this essay, Vol. VII, No. 2).

MATURE OUTLINE ADJUSTED TO STRUCTURE

In profile the southern part of the Wellington west coast is mature in the current cycle. This is south of the segment embayed by submergence to make Porirua Harbour, a system of branching drowned valleys (*Figs.* 1, 6). Considerable parts of the south coast are certainly upheaved, as is shown by the presence of marine terraces (*Figs.* 4, 5). In the terraced parts the profile is approaching maturity, and it is fully mature at places where terraces no longer survive. The criterion of maturity for such upheaved coasts is that defined by Putnam:[15] that the terrace-making platform fringing an emergent shore has been destroyed by marine erosion. A coast of submergence cannot develop a similar profile of maturity until mature also in outline, that is, until it becomes a continuous line of cliffs as a result of retrogradation beyond the heads of the initially drowned valleys;[16] this generally involves much cliff recession and must in such cases be a very lengthy process. The maturity of profile exhibited by those high-cliffed parts of the Wellington coast that are without terraces thus suggests origin by emergence. That these are not of a great age (in years) may be

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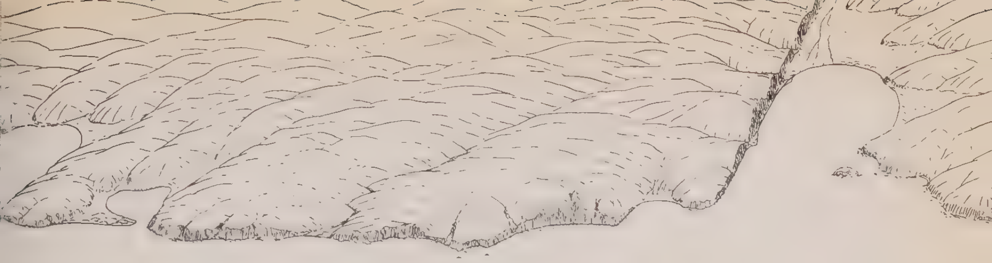
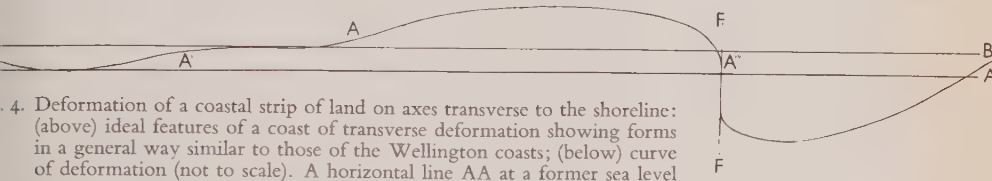
[14] C. A. Cotton: 'Accidents and Interruptions in the Cycle of Marine Erosion', *Geogr. Journ.*, Vol. 117, 1951, pp. 343-349.

[15] W. C. Putnam: 'The Marine Cycle of Erosion for a Steeply Sloping Shoreline of Emergence', *Journ. Geol.*, Vol. 45, 1937, pp. 844-850 (see p. 849).

[16] Such is the definition standardised by Johnson (*op. cit.*, 1919, p. 341), following W. M. Davis: *Die erklärende Beschreibung der Landformen*, Leipzig, 1912, p. 511.





4. Deformation of a coastal strip of land on axes transverse to the shoreline: (above) ideal features of a coast of transverse deformation showing forms in a general way similar to those of the Wellington coasts; (below) curve of deformation (not to scale). A horizontal line AA at a former sea level suffers warping and dislocation so as to become AiAiiAiiiAivAv; while at the same time the level of the ocean rises to BB. FF, fault.

inferred from the fact that adjoining parts of the coast retain the outline of youth—these being in segments drowned by a presumably simultaneous submergence.

The outline also of the cliffed coasts approaches or has attained maturity, if this may be defined as a condition of stability of form notwithstanding continuing retrogradation. Such an outline is not necessarily straight, but may, indeed as pointed out by Challinor,[17] be decidedly sinuous. Like the transverse ridge-and-valley profile of a mature land surface, the coastal outline must become adjusted to structure. In the case of the coast in question there seems to be nearly perfect adjustment of the terrain to the structure. The continuously cliffed shoreline, crossing the grain of the land transversely on the south coast and very obliquely on the west coast, has retreated farther on the outcrops of the weaker rocks, so as to develop a *persistent* sinuosity (*Fig.* 3). There are two reasons for this: the weaker material yields more readily to wave attack; and subaerial erosion has earlier selected and excavated weaker belts as furrows across the landscape, at the ends of which marine erosion and transportation have less debris to dispose of for each unit of retrogradation than on the ridges formed by belts of more resistant rock.

The development by erosion of a continuously cliffed shore with irregular sinuosity must be attributed to the work of the sea in earlier cycles as well as in that now current; for the parts of the cliffs most obviously produced by marine erosion in the current cycle give an impression of only moderate retrogradation of the shore (*Fig.* 3). They truncate the margin of the maturely-dissected land surface, a reconstruction of which by 'decliffing' would produce an outline nearly parallel with that now existing. Sinuosity of the outline thus restored cannot, however, be explained by a hypothesis of drowning, for, insofar as it appears related to the pattern of valleys in the hinterland, the relation is most satisfactorily explained by the hypothesis of selective subaerial and marine erosion outlined above.

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[17] John Challinor: 'A Principle in Coastal Geomorphology', *Geography*, Vol. 34, 1949, pp. 212-215 (see p. 214).

It is well known that in general marine erosion destroys rather than produces intricacy of coastal outline.[18] A shoreline developed to maturity and still undergoing retrogradation across a belted terrain must, nevertheless, attain a sinuosity adjusted to and appropriate to the structure. This is perpetuated as long as the coast continues to be cut back across terrain with similar structure, concurrently with progressive elimination of any tectonic salients that tend to appear, as has been described in the introductory part of this essay (in Vol. VII, No. 2).

Dating Transverse Deformation

It would be unsafe to assume that the latest considerable shift of sea level on these Wellington shores has been, as in many other parts of the world, that produced by the Flandrian transgression. A local upheaval affecting the coast having been observed in 1855, and the district being strongly seismic, a late date is possible for the major deformation referred to above.

For systematists concerned with the problem of classification, interest centres on the question whether any parts of the coastal outline are coasts of emergence *in the current cycle*. The alternative hypothesis to this is that the major warping and faulting of the land were pre-Flandrian, so that all parts have been later subject to eustatic submergence. One segment of the south coast is so deeply drowned (in the warped basin forming Port Nicholson) as to indicate a maximum (axial) submergence amounting (together with the latest eustatic shift) certainly to more than a thousand feet and perhaps to as much as 1500 feet[19] (*Fig.* 2), though heavy sedimentation fed by abundant silt from the Hutt River has buried the submerged relief. Other parts of the coast have just as clearly been upheaved at no very distant date, being fringed by marine terraces (*Fig.* 5). The actual date of the diastrophism thus indicated is obscured by changes due to marine erosional development; but, as this is proceeding very rapidly, such changes do

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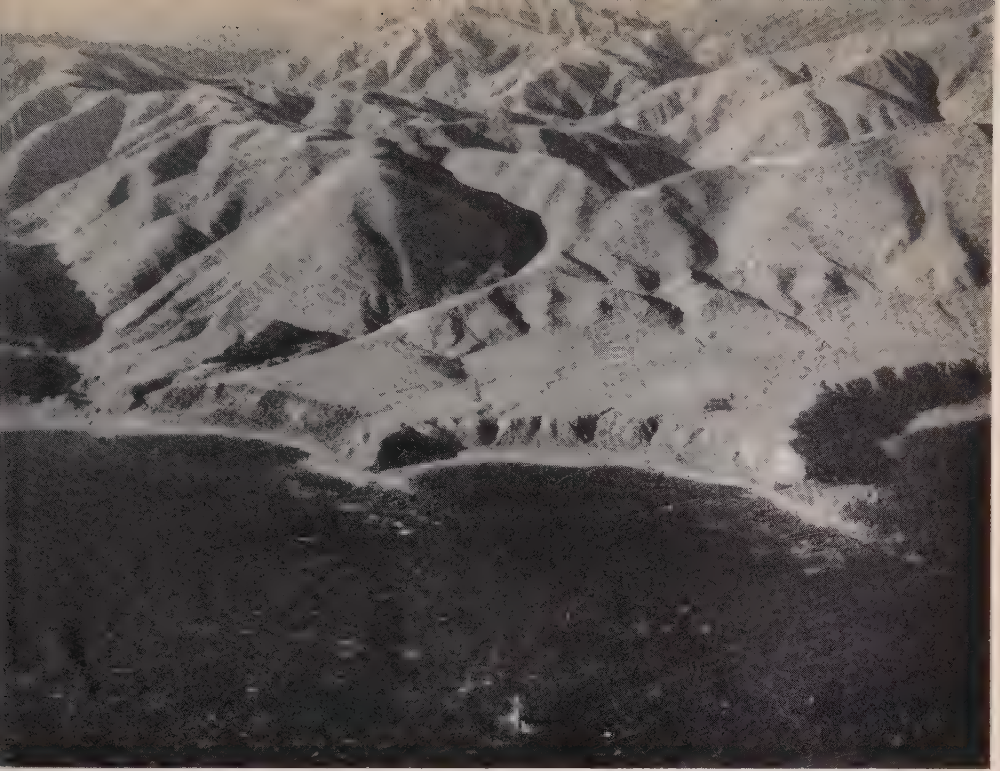
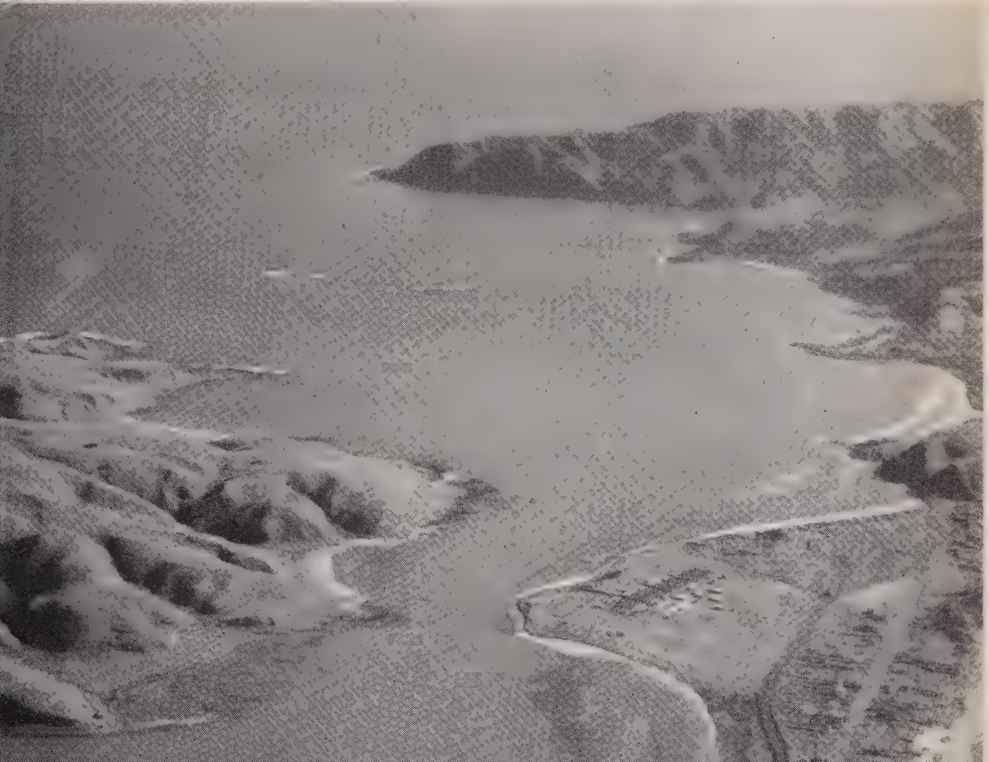
[18] Johnson: *op. cit.*, 1919, p. 176.

[19] C. A. Cotton: *op. cit.*, 1921, p. 133.



Tongue Point, on the south coast, at Wellington, showing two marine terraces, the
well preserved, and the upper narrow and dissected. Photo: Ministry of Works)

Entrance to Porirua Harbour drowned-valley system. (Photo: Ministry of Works)



not imply a great lapse of time. Parts of the upheaved coast are now mature in profile and in outline, and a mature coast may be enigmatic: by convergence of development maturely retrograded coasts of submergence and of emergence can become indistinguishable.

The immediate problem is to reconstruct as far as possible the outline at the commencement of the current cycle, and thus incidentally to date the transverse deformation the coastal land has suffered. Features of valleys that are not drowned may help to answer such questions. It is clear that if any marginally dissected land fails to show proof of drowning by the Flandrian transgression, some special explanation must be found for this. Its shoreline may have been prograded progressively during the transgression; it may have been retrograded to maturity by post-Flandrian erosion; or it may have been upheaved either since or during the transgression. The first of these conditions should generally be recognisable; the second is unlikely in a hardrock terrain, but should be recognisable if it has taken place; the third may perhaps afford an acceptable explanation of parts of the Wellington coast.

THE MAKARA VALLEY

Only one extensive and deeply incised valley, that of the Makara, opens on the western coast south of the drowned Porirua Harbour area (*Figs.* 1, 6). The fact that it is not drowned is significant. The main Makara valley is maturely open inland (*Figs.* 7, 8), though in its lower part the inner valley (of the current cycle) is somewhat constricted where it turns northwestwards across the grain of the terrain. The Makara Stream, graded or nearly graded throughout, meanders on a flood plain for the full length of the valley. Presenting features of two very distinct geomorphic cycles, this valley in the heart of the Wellington Peninsula dates necessarily from quite ancient times; it has very obviously not been developed to its widely-open, mature, two-cycle form since the final postglacial eustatic stabilisation of ocean level. Neither has it been initially drowned as a whole in the Flandrian transgression and then infilled with alluvium to produce the present graded condition; there is an appearance of only slight drowning (followed by infilling) for about a quarter of a mile at the mouth. The absence of an extensively aggraded valley floor, which shows that the valley has escaped postglacial drowning, makes it clear that an upheaval of this part of the coast has almost neutralised the effect of the Flandrian transgression in producing submergence (compare *Fig.* 4, Aii Aiii.)

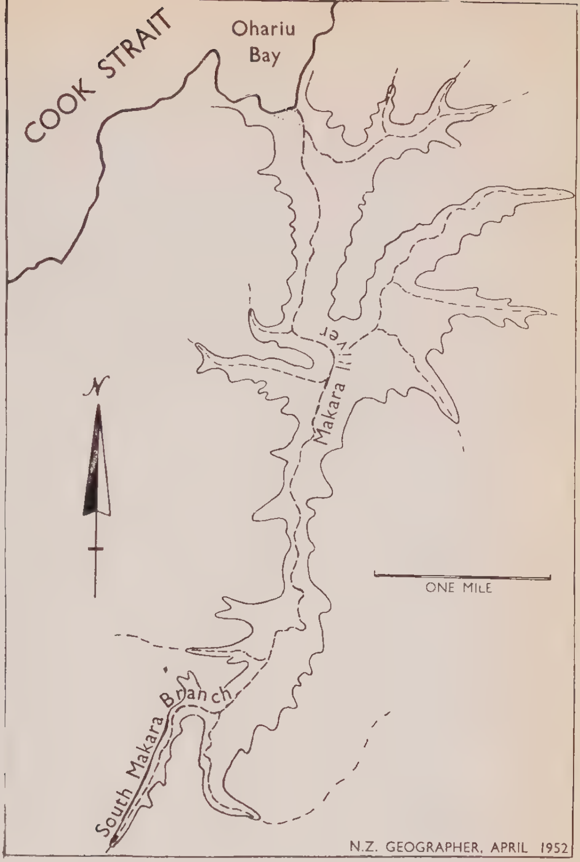


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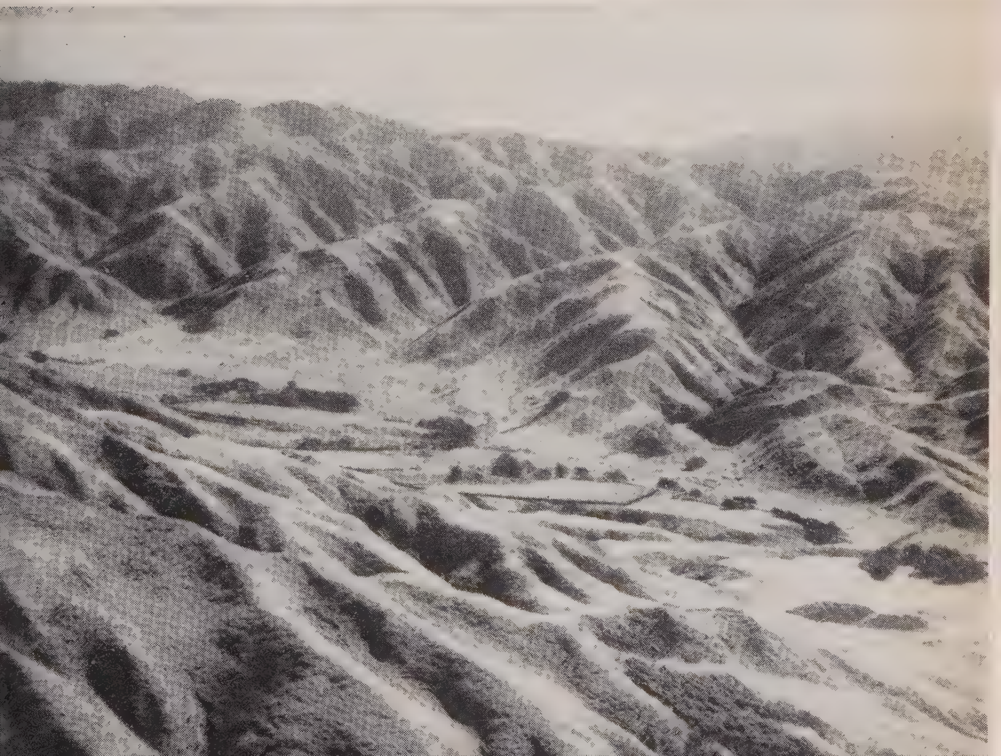
Fig. 7. Makara Valley outlined by the 200-ft. contour.

Fig. 8 (below). View looking west across the upper reach of the Makara Valley (South Makara branch). The narrow inner valley of the current cycle is bordered by wide terraces made by the valley floor of an earlier cycle. (*Photo: Dept. of Geography, Victoria University College*)



Three miles up the valley there is, however, an outcrop of a beach or shallow-water deposit of fine gravel containing fragments of marine shells of uncertain age. Though the only known outcrop is exactly at the level of the flood plain of the current cycle, here a hundred feet above sea level, this bed must be older than the flood plain, by which it is truncated. It is also described as covered by river gravel, subsequently trenched and in part removed in the latest stages of valley erosion.[20] The formation of a beach far within a valley of contour like, though not identical with, that now existing may mean that the Makara area was drowned by eustatic submergence in one of the interstadials, W1-W2 or W2-W3, or in very early Flandrian time while the level of the ocean was still low, to be upheaved later by earth movement. If so, it may be inferred by extrapolation that throughout the district most of the warping has taken place at least within the last 100,000 years, and is probably quite recent, though it is not necessarily post-glacial in a restricted sense. The slightly drowned (and infilled) condition of the mouth of the Makara suggests that stability of the land had been attained shortly before ocean level reached approximately its present position considerably less than 10,000 years ago.[21]

Dating of the warping earlier than Flandrian would make it difficult to explain the present condition of the Makara valley—why it has escaped deeper excavation in the last glacial age. Such excavation, if it had taken place, must have been followed by extensive drowning in the Flandrian. The valley is now of suitable shape and depth to make a large landlocked embayment if the ocean level were to rise two hundred feet (*Fig.* 7).

Broad remnants of a former valley floor which survive as somewhat dissected terraces flanking the valley throughout its length have been tentatively correlated in an early account of Wellington geomorphology[22] with the lowest and best-preserved of the marine terraces on the south coast. The correlation was based merely on similar altitude, however, which, it is now obvious, means little in this strongly warped district. Antiquity of the Makara valley terraces, which are largely rock-cut, is indicated by the stage of their dissection, and it would be consistent with the foregoing suggestions as to the history of the valley to correlate the valley floor from which they are cut with relics of an older, dissected marine terrace, as Gage[23] has done. The correctness of Gage's assignment of this ancient valley-floor to an episode of aggradation caused by submergence following deposit of the marine shelly gravel is doubtful, however. He assumes the shelly gravel to be Pliocene; but the age of unidentified shell fragments in it may just as well be late Pleistocene or even early Flandrian.

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[20] Maxwell Gage: 'The Makara and Karori Valleys and their Bearing upon the Physiographic History of Wellington', *Trans. Roy. Soc. N.Z.*, Vol. 69, 1940, pp. 401-409 (see p. 404).

[21] For comparison it may be noted that G. Imamura, calculating from the ratio of average tilt to observed annual rate of tilting now in progress, finds that the upheaval of warped marine terraces at several places on the coasts of Japan has required about 100,000 years. ('Raised Beach Studies in Japan', *C. R. Cong. Internat. Géogr. Lisbonne 1949*, 1950, Vol. 2, pp. 507-510.

[22] Cotton: *op. cit.*, 1912, p. 250.

In the embayed part of the western coast at Porirua Harbour (*Fig.* 6) there is little or nothing to suggest recent tectonic submergence. The drowning is not so great that it cannot be accounted for by eustatic submergence. It appears that this area escaped the latest diastrophism and therefore throws no light on its date.

The great downwarping and fault subsidence at Port Nicholson (*Figs.* 1, 2), on the other hand, involve submergence on a scale that makes the postulation of diastrophism necessary. Evidence in favour of a Flandrian, or perhaps even later, postglacial age for this (and, by extrapolation, for the transverse deformation of the whole district) may be inferred from the condition of dissection of the Wellington fault scarp where it descends to the shore and plunges into the drowned basin (*Fig.* 2). Numerous streams which flow into the basin across the scarp spout from hanging ravine mouths, and only the three largest debouch at sea level. Though the valleys of these are graded for a short distance up from the mouths, they appear not to have been drowned. It is thus probable that the final movement on the fault (though there had been also earlier faulting movement) took place little, if at all, earlier than the final stage of the Flandrian transgression.

TERRACED SHORES

The higher steps of the flights of marine terraces bordering strongly emergent parts of the south coast at Wellington (notably the dissected terrace at Tongue Point and several east of Baring Head) are ancient enough to be dated earlier than Flandrian, if one may judge from the amount of debris that has accumulated on them as fans and talus to form a cover head, by the extent to which they have been trimmed back by marine cliffing at intermediate levels, and by the dissected condition of some of their surviving remnants (*Fig.* 5).

The lowest and best preserved terrace, however, seems to be of an age comparable with that of the '100-ft. raised beach' terrace of western Scotland.[24] Such comparison may fairly take into account the undissected condition of the terraces except where trenched by quite large streams extended across them from the hinterland, the stage of dissection of hardrock cliffs at the rear, the limited amount of cover head on the terraces, and the relatively small extent to which the margins of the cut-rock platforms are cliffed back (see *Fig.* 5). Time is but one of the factors determining the stage of erosional destruction, and is in some cases a minor factor. This method of comparison as a means of measuring age in years is, therefore, very rough; but it may be used for want of a better to estimate the antiquity of this distinctive feature of the Wellington coast. The Scottish terrace it is compared with dates only from the late postglacial isostatic rebound and is unlikely to be more than 10,000 years old.

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[23] *Op. cit.*, p. 405.

Subsequently to intermittent upheaval (accompanied by some warping) in the lengthy process of marine terrace development at Wellington, the terraces have been tilted endwise (*Fig.* 4) by the later earth movements which have upheaved and strongly warped parts of the coast and have depressed the Port Nicholson basin. It is found also that remnants of terraces which may be tentatively (and plausibly) correlated on different parts of the coast are at different altitudes,[25] affording some clues to minor corrugation in the pattern of transverse coastal deformation.

The lower or main terrace quite possibly registers the position of the shoreline prior to a major deformation, for which a Flandrian date is inferred from the state of preservation of the terrace.

It cannot be claimed that the main diastrophism was entirely subsequent to the late Flandrian stabilisation of ocean level, but movements certainly continued into quite recent times. Some light may be thrown on the date of the coastal deformation by an investigation which has been made by pollen analysis of peat filling a swamp at Wallaceville, in the Hutt valley system, for the origin of the basin containing this may be reasonably regarded as due to the last (or one of the latest) spasms of differential earth movement. According to Harris[26] its infilling with peat began about seven thousand years ago.

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[24] Compare a view near Rhuvaal, Islay, figured by D. W. Johnson, *op. cit.*, 1919, p. 227.

[25] L. C. King: 'Raised Beaches and other Features of the Southeast Coast of the North Island of New Zealand', *Trans. & Proc. N.Z. Inst.*, Vol. 61, 1930, pp. 498-523 (see p. 502); *idem:* 'The Relation between the Major Islands of New Zealand', *Trans. Roy. Soc. N.Z.*, Vol. 68, 1939, pp. 544-569 (see p. 551).

[26] W. F. Harris: 'New Zealand Plants and their Story: Clues to the Past', *N.Z. Science Review* Vol. 9, 1951, pp. 5-9 (see p. 8).

THE MAORI IN NORTHWEST NELSON ABOUT 1840

A. J. ROSE

THE APPLICATION of geographical techniques to the study of pre-European Maori settlement in New Zealand has gathered momentum in recent years. In particular Lewthwaite and Cumberland have shed new light on the Maori occupation of New Zealand.[1] The present article deals with the relatively small northwestern corner of the South Island and examines that area in terms of the number and distribution of Maori population about 1840, and the pattern of settlement, communications and trade. The conclusions arrived at herein result from the study mainly of library data, for although considerable fieldwork has been carried out in the area in the study of contemporary land use, little was done specifically on the subject of the early Maori settlement pattern.

The Pattern of Settlement

The Maori settlements of the South Island were concentrated largely around the northern littoral and along the east coast as far south as Banks Peninsula. At the time of the first permanent European settlement in northern parts of the South Island the situation among the Maori was complicated by the recent raids and conquests of Te Rauparaha who operated from Kapiti and Horowhenua. In northwest Nelson these raids resulted in the extirpation of the original inhabitants who were either killed, enslaved, or forced to flee southwards. The North Island conquerors who replaced these people formed a new population settled in small coastal villages and characterised by distinctly migratory habits. Thus, not only did the newcomers shift at frequent intervals from one locality to another within the region, but they also moved frequently to and from their northern homeland.

The first European to leave a detailed record of early Golden Bay was Tuckett whose report appears in the *Nelson Examiner* of 9 and 16

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[1] Gordon Lewthwaite: 'The Population of Aotearoa: Its Number and Distribution', *N.Z. Geographer,* Vol. 6, No. 1, 1950, pp. 35-52. Kenneth B. Cumberland: 'Aotearoa Maori: New Zealand about 1780', *Geogr. Review,* Vol. 39, No. 3, 1949, pp. 401-424; and *idem* 'A Land Despoiled: New Zealand about 1838', *N.Z. Geographer,* Vol. 6, No. 1, pp. 13-34.

April 1842. Tuckett 'took some pains to ascertain the population of the bay and its vicinity' and arrived at a total of 174 Maori living in scattered villages between Separation Point and Westhaven (West Wanganui) Inlet. A peculiar feature of Maori occupation at this time was the practice, common to at least two of the village groups, of having cultivated land at a considerable distance from the village itself.[2] Thus the Maori living at Tata in the vicinity of the present Ligar Bay had gardens some distance up the Takaka River, gardens which excelled any that Tuckett had seen elsewhere. The Maori of Pakawhau Inlet similarly worked gardens at a distance, notably on the northwest coast between Cape Farewell and Westhaven Inlet.

Evidence of Population Changes

After Tuckett's visit the population of the district appears to have increased considerably. Some months after the publication of Tuckett's report the first white settler arrived in Golden Bay, 'landing among a crowd of 200 or 300 Maoris at the native village on the beach at Motupipi'.[3] This village was in a locality which Tuckett visited and where, although he found coal, he found not a single Maori. But reports from 1842 onward indicate that Motupipi continued to be the largest Maori village in the area. Further, the *Statistics for Nelson, 1845* give a Maori population of 325 in Massacre (Golden) Bay, or almost double the figure computed by Tuckett three years earlier.[4] This provides a measure of the rapidity with which the Maori at that time moved from place to place. The late-1842 arrivals at Motupipi came from Taranaki, to which district most of them returned several decades later. This implies a deserted, or partially deserted, village in Taranaki, itself evidence no doubt to any European in that area at the time that the land was becoming 'depopulated'. It would, however, not necessarily provide evidence that the total number of Maori in the country as a whole had declined.[5]

Such abandoned settlements were also common in northwest Nelson at the time of early white settlement. Although in 1827 D'Urville failed to note any sign of habitation on the west coast, a shore party from his ship discovered abandoned huts at Separation Point.[6] Whether these were temporary shelters for migratory hunting groups or buildings abandoned by permanent residents it is impossible to say. But Tasman had certainly found this area quite thickly populated almost two hundred years earlier. Even after 1842 it was the habit of the Maori in Golden Bay to move freely from locality to locality building and abandoning dwellings as they went. For example, the site of Collingwood was occupied from time to time by the residents of the bay until Collingwood mushroomed into a mining metropolis

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[2] A possible explanation for this was that the gardens occupied areas formerly cleared and cultivated by the earlier inhabitants, near which the conquerors were unwilling to live but which were under no *tapu* in regard to cultivation. The extent of 'Maori Soils' near Takaka (Cawthron Institute *Soil Map of Takaka County*, 1 : 63,360) was, in 1842, far too great to have been the work of the small village cultivating the area at that time.

[3] J. Halkett Millar: *Beyond the Marble Mountain*, Nelson, 1948, pp. 1 and 10.

[4] See *Nelson Examiner*, 4 April 1846. The same source on 19 April 1856 gives a figure of 209 Maori in the district.

[5] Cf. Lewthwaite, *op. cit.*, pp. 44-45.

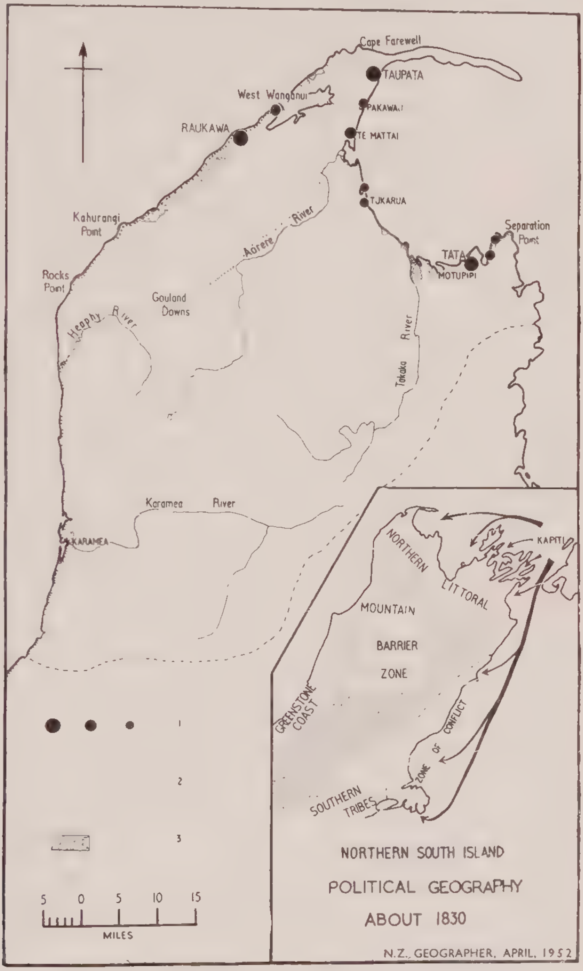

Fig. 1. Maori settlement in northwest Nelson in 1842.

Population of Maori vil-
ges in March 1842; circles
present 30, 20 and 10 per-
ns (data from Tuckett).

Overland routeway for-
erly used in transporting
eenstone from the Arahura.

Areas showing evidence of
rmer Maori occupation
ter Heaphy and Mitchell).
set, direction of Te Rau-
raha's invasion.

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[6] A report translated by A. N. Field and published in *Nelson Province, 1642–1842,* Nelson, 1942, pp. 29–31.

in 1857. The remains of small temporary settlements of this nature would promote the impression of a larger population in earlier times.

Nevertheless, along the coast south of Westhaven evidence of permanently-abandoned settlements was abundant. Of this area Tuckett said that settlements existed whence the people had moved to 'the Orowrra' (Arahura?) twenty days' journey southwards along the coast. Heaphy and Brunner travelling this way south of the Paturau River in 1846 reported: 'at intervals . . . the remains of small pahs, the provision stage or portion of a stockade showing itself amongst the bush which had overgrown the former plantation. The natives had given up the country in order to locate themselves nearer the greenstone streams in the south'.[7] It is probable that this southward movement was associated with the activities of Te Rauparaha. Along the Karamea Coast there was no Maori settlement in the 1840's although Mitchell mentions sporadic visits to the area by hunting parties, and 'a sub-tribe of the Ngatirarua who settled in the district about 1750'.[8] Heaphy and Brunner also mention an overgrown potato patch at the mouth of the Heaphy River and the presence of a track leading overland from that point to the Aorere valley.[9]

In assessing the available evidence it appears that in northwest Nelson in 1842 the people were migratory in habit and the population total tended to fluctuate rapidly. Therefore numerous signs of previous habitation did not necessarily indicate a larger population at an earlier date. However, evidence definitely points to a higher population along the west coast some time prior to 1842 and there is also reason to believe that the population of Golden Bay exceeded the March 1842 figure at an earlier date. In this connection there is not only the evidence of Tasman and the extensive 'Maori Soils' at Takaka but also the locally-held tradition (not mentioned by Travers[10]) that some 600 Golden Bay Maori were put to death over the precipice at Rangihaeata Heads by the invaders from Kapiti. However, without detailed archaeological fieldwork it is impossible to make any accurate estimate of the pre-Te Rauparaha population of the area.

COMMUNICATIONS AND TRADE

A review of Maori trade in the area reveals some points of interest. Apparently a proportion of the greenstone from the Arahura locality moved north overland along the coast. It is possible that the route forked at the Heaphy River whence the inland branch crossed the Gouland Downs and followed the Aorere down to Golden Bay, while the coastal route traversed the exceedingly rugged country about Rocks Point (here Heaphy says 'the ropes were rotten and the descents difficult') before reaching Golden Bay via Westhaven Inlet and Pakawau Gorge. In respect to greenstone, northwest Nelson was, therefore, merely an area of transit between the mining area at Arahura and the 'consuming' area of the North Island and also, apparently, an area through which this trade had almost ceased to flow by 1842. But several minor commodities had their origin in the region. Mitchell mentions the export both north and south at an early date of scented pigeon oil from Karamea.[11] A rather unusual item was noted by Heaphy and Brunner: 'Between [West] Wanganui and Cape Farewell, but I do not know the spot, is found the *pakaki*, or pitch, which the natives are fond of chewing, and which is sent by them to all parts of New Zealand.'[12] Finally, but apparently without supporting evidence, is the statement of Bell concerning the deposits at Parapara that, 'in the early days before the advent of white people, the iron-ore was used by the Maoris for making paint'.[13]

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[7] *Nelson Examiner,* 12 Sept. 1846.

[8] G. G. M. Mitchell: *Maori Place Names in Buller County,* Wellington, 1948, pp. 29-33.

[9] *Nelson Examiner: loc. cit.*

[10] W. T. L. Travers: 'Life and Times of Te Rauparaha', *Trans. & Proc. N.Z. Inst.,* Vol. 5, 1872.

CONCLUSIONS

Similarities between the present settlement pattern of the whole northwestern portion of the South Island and that existing among the Maori 110 years ago are striking. The Maori of Tasman and Golden Bays were more closely allied both in interests and in culture with the southern areas of the North Island than with their neighbours along the 'Greenstone Coast' to the southwest; the people of this latter area had strong transmontane affiliations with the tribes of Canterbury.[14] Between these two 'regions of community interest' (analogous with modern Nelson and Westland) extended a broad and unattractive barrier zone of high mountains and rugged coasts stretching from Kahurangi Point southwards to the vicinity of the Grey River. That the more favoured areas within this barrier zone were utilised from time to time is shown by such evidence as the great heaps of *pipi* shells, remnants of mighty feasting, near the mouth of the Karamea River. The development of modern communications in the area, particularly the road down the Buller Gorge, and the utilisation of such resources as coal and timber with associated settlements, has tended to blur the original clearcut pattern, but even today the sympathies and centres of interest of the Nelson and West Coast-Buller areas are strongly divergent. The one looks to the southern North Island, the other, with its railway through the Otira Tunnel, has Christchurch as its metropolitan focus. Nelson rests solidly on an intensive agricultural form of land use; much of the wealth of West Coast-Buller comes from the exploitation of minerals. Gold, and particularly coal, have replaced the *pounamu* in a mining economy which made this area the focus of mineral production long before Europeans came to New Zealand.

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[11] Mitchell, *op. cit.*, p. 32.
[12] *Nelson Examiner*, 5 Sept. 1846
[13] J. M. Bell: 'Parapara Subdivision', *N.Z. Geol. Surv. Bull. No. 3* (New Series), 1907, p. 18.
[14] See Cumberland, 'Aotearoa Maori . . . etc.', *op. cit.*, p. 411 (map).

NEW ZEALAND GEOGRAPHICAL SOCIETY BRANCH AFFAIRS

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Committee: Mr. W. J. A. Brittenden, Mr. W. J. Clark,
Mr. J. K. Cunningham, Miss N. Clark, Mr. M. McCaskill

The September meeting in 1951 was addressed by Mr. T. R. Pogson of the British Colonial Service on the topic 'East Africa Today'. Three Honours students of Canterbury University College spoke to the October meeting of the branch on aspects of their investigations for their M.A. theses. Newsletters during 1951 aimed at providing a geographic background to international affairs and in view of their popularity it is hoped to extend this service in the current year. It is also proposed to include regular film evenings and field excursions in the 1952 programme in addition to the monthly meetings.

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Mr. A. J. Sligo

The following programme was presented during the year: 'The United Nations and Geography' by Mr. W. B. Harris; 'The Exploration of New Zealand by Dumont D'Urville', by Miss Olive Wright, who lectured in the Alexander Turnbull Library, using D'Urville's original log books; an illustrated lecture on 'The Inca Country' by Dr. J. S. Cumpston; 'Indian Agriculture' by Mr. Bimalendu K. Lanyal. In addition, three film evenings were held.

Meetings were on the whole well attended during the year, especially that held by permission of the Trustees in the Alexander Turnbull Library. In an endeavour to build up the membership of the branch, contacts were made with secondary school pupils. In addition, initial steps were taken to form a Geography Teachers' Group.

AUCKLAND BRANCH

OFFICERS for 1952 are— *President:* Dr. E. P. Neale

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Hon. Auditor: Mr. J. K. Bedbrook

Committee: Mrs. J. Collins, Miss A. J. Metge, Mr. K. B. Radford

For 1952 it is hoped to arrange an attractive and varied programme in which overseas and New Zealand speakers will participate. An attempt has been made to include topics with a wide general appeal in order to attract not only members but also the general public to the meetings. The policy of having film evenings is to be continued and two interesting field excursions have been arranged.

The branch would like to record its deep appreciation of the work done by Mr. R. G. Lister and Mr. W. B. Johnston. Mr. Lister has taken up the Senior Lectureship in Geography at the University of Otago and Mr. Johnston has accepted a Junior Lectureship at the University of Nottingham, England.

OTAGO BRANCH

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Chairman: Mr. R. G. Lister

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Committee: Miss J. E. Bisset, Miss E. L. Elliott, Miss R. Hampton, Mr. J. U. Macaulay, Mr. D. Sage

The concluding sessions of the branch for 1951 were well attended. The July meeting saw an innovation in the form of a Students' Evening, when three Honours students presented an account of their theses and research to an interested audience. In August, Miss M. B. Kibblewhite acted as reviewer of a series of films on various aspects of Australian life; and in September, Professor J. I. Graham of the Otago School of Mines gave an illustrated address on 'Coal Mining in Great Britain'.

The branch is sorry to lose the services of Mr. Alan Tweedie who is leaving this year to join Mr. R. H. Greenwood in Brisbane. His activities as secretary-treasurer and council delegate have made an invaluable contribution to the life of the branch. We wish him well in his new sphere of activities.

GEOGRAPHIC NOTEBOOK

CONTRIBUTORS TO THIS ISSUE. New Zealand has often had to rely on the observation of visitors from overseas before it has come to appreciate the seriousness—even the existence—of problems within its boundaries. Robert Cushman Murphy is another visitor to the dominion—though not the first—who has felt impelled to comment on the often disastrous impact of alien flora and fauna upon the native wild life and pristine landscape of New Zealand. Dr. Murphy is entitled to comment. In the United States, where he is Chairman, Department of Birds, American Museum of Natural History in New York, he is a recognised authority in his field. He has made several visits to this country, most recently on the occasion of the meetings of the Seventh Pacific Science Congress early in 1949. On these visits he has not been content with the four main centres; but he has explored the remote corners of the two main islands and visited more of the outlying islands than all but very few New Zealanders. The paper he read in 1948 before the American Philosophical Society was thought to be of sufficient interest to New Zealanders that permission was sought to reproduce it in abbreviated essay form in the *New Zealand Geographer*. The thanks of the New Zealand Geographical Society are due to Dr. Murphy for acceding to this request.

The Christchurch and Auckland metropolitan areas have been surveyed by geographers in recent years and the results of their work have been published in previous issues. It is appropriate to publish a third addition to the survey of the urban geography of the four main centres. Mr. A. D. Tweedie, Assistant Lecturer in the Department of Geography in the University of Otago, with a training in both history and geography, has now spent some years mapping and analysing the morphology and land use of metropolitan Dunedin. The present article is a synopsis of a thesis submitted for the Degree of Master of Arts in Geography in 1950.

With the death last year of Sir Albert Ellis New Zealand lost the services of a man who has done a great deal for this country and who was an active member of the society. A long period as New Zealand representative on the British Phosphate Commission and an intimate acquaintance with the insular sources of phosphate on which both Australia and New Zealand so largely depend, make the present article, written shortly before his death, an authoritative statement on a source of phosphate supply that in years to come must be an essential basis of the New Zealand economy.

Professor C. A. Cotton of Victoria University College continues in this issue an investigation of shoreline classification, the first part of which appeared in Volume VII, Number 2; and Mr. A. J. Rose, now Lecturer in Geography at the New England University College, Armidale, New South Wales, contributes a note on the Maori population of Nelson about 1840. This is a by-product of his fieldwork in that region reported here in the issue of October 1950.

Readers of the journal will notice the absence on this occasion of the feature introduced in 1948 entitled *Photogeography*. It has not been abandoned, but rising costs, especially of blocks, have made it impossible to include *Photogeography* for the time being in every number. A photographic account of the air transport industry of the dominion will appear in the next issue and it is hoped to publish a *Photogeography* feature in every other issue thereafter.

Among other contributors—of reviews, short notices and comments—to this number are: Professor G. Jobberns and Mr. A. J. Danks of Canterbury University College; Professor R. O. Piddington, Mr. L. H. Millener and Mr. B. H. Farrell of Auckland University College; Mr. A. D. Tweedie of the University of Otago; Mr. G. Guy of Christchurch Teachers' Training College; Mr. J. U. Macaulay of Dunedin Teachers' Training College; Mr. G. Lewthwaite of the University of Wisconsin; and the editorial staff.

The index to the *New Zealand Geographer*, Volume VII, has been prepared by Miss E. Banks and is sent out with this number.

THE MAINTENANCE OF NEW ZEALAND'S GREEN MANTLE. Contained in the Ministry of Works Statement for 1951 is the Ninth Annual Report of the Soil Conservation and Rivers Control Council. Though the chairman (Mr. W. L. Newnham) sounds a note of some disappointment at the limited progress made during the year, the record of the council's activities in a wide variety of fields is impressive. The council is an administrative authority exercising a general supervision over twelve catchment boards, and over work done by the Ministry of Works itself in areas for which no catchment board has so far been set up. The report makes a bald statement of what has been done during the year: 'A total of 44¾ miles of river banks have been protected against erosion, 43¾ miles of stop bank built, 126 miles of river channel cleared, and 128¾ miles of drains reconstructed. Maintenance of drains and river channels, so much neglected in the past, is being organised on a sound basis with the encouragement of the council's subsidies. Several new types of equipment have been developed to speed the work. During the year 619½ miles of main drains were cleared and control works on 209 miles of rivers were maintained.' In a country with so many streams and swampy places needing attention this may not seem significant, but considering all the present day difficulties of labour and finance it is a very creditable achievement. Most of the £520,436 appropriated for the council's work was spent on river control and on drain construction and maintenance, but some little indication of the magnitude of the task ahead is given by the note that proposals already brought forward for river-control schemes involve expenditure up to £1,000,000. The council's duties and responsibilities are vast.

The council is not merely an authority for supervising control of river channels and for the making and maintenance of drains. Conservation of soil, maintaining and improving the natural cover of vegetation in high country and generally guarding the productive capacity of the land all come directly or indirectly under its care. Of course various government departments carry out much of this work as part of their routine duty, but the report of the council records its achievement in a close and efficient coordination of all these activities. Accordingly the council is concerned with how the Department of Lands manages the vast hinterland areas vested in the Crown; how the New Zealand Forest Service has a care for keeping the upper catchments of rivers clothed in native forest; how the Wild Life Division of the Department of Internal Affairs keeps in check such pests as deer, oppossums and wallabies. Of special concern to it is the control of fires in the backcountry.

Amid all this the council sees that the clearest way of realising its policies of conservation lies in education of the people themselves. Though its work has been handicapped by shortage of staff, the record in this educational field is most creditable.

Many of the ramifications of the work of the council are also noted. The important project of obtaining more accurate records of rainfall and runoff in the high country catchment areas proceeds steadily. No less than ten demonstration and experimental areas are operated. These cover the high country of the South Island in North Otago and Southland, pastoral hill country in the North Island, slip-eroded slopes in Hawkes Bay, low rainfall tracts in Marlborough, and the eroded downlands of South Canterbury, where the efficacy of contour ploughing is demonstrated. A 'contour works unit' conducts practical demonstrations on farm properties, and over 1700 acres have been treated to date with the general object of showing how to reduce runoff and to stabilise the soil. Farmers are shown on the spot the nature and use of pasture furrowing, broad base terracing, contour banks, grass waterways and diversion ditches. It is noted also that the first detailed survey of an entire catchment area has been completed, presumably as a pilot project to show how best methods of permanent land use may be estimated.

Of special topical interest is a note on the progress of aerial topdressing. Two years ago large-scale field trials in the Wairarapa were organised, mainly by the council, and have led to an amazing development of this method of improving hilly country. There are now eighty light aircraft fitted with fertiliser hoppers, and other countries have become interested in this method pioneered in New Zealand.

Mr. Newnham makes a very modest statement of what the council has been able to do in 1951, in the face of difficulties, and seems disappointed that more has not been achieved. Anyone reading this report, however, must agree that the council, shouldering an enormous job, has not done so badly.—G. JOBBERNS

PLACE GEOGRAPHY. A knowledge of 'place' geography—the ability to locate a town or country—is surely essential for the average citizen who wishes to talk intelligently about world affairs, just as it is for the geographer who wishes to fix one place with reference to another. The 'capes and bays' geography of the past had some virtues in this respect, and these appear to have been overlooked by those who have discarded it completely in favour of 'social studies' or of 'modern' geography.

From two investigations carried out in Christchurch it would appear that there is need for a greater awareness of the significance of location as such in the teaching of geography in schools. Whether the children are better informed generally—or less so—than in the past is beside the point. There is room for great improvement, and such does not involve any changes of syllabus. As the results of the following tests show, teachers need to insist on a more definite factual knowledge.

In 1951 new entrants to the Christchurch Teachers' Training College were asked to locate fourteen towns on blank maps of New Zealand. The number of students tested was 164, and of these 102 had passed geography at the School Certificate level, at least, and sixty-two had studied the subject very little or not at all.

In allotting marks more tolerance was allowed for inland towns such as Taumarunui or Hamilton than for towns such as Westport or Whangarei which could be fixed in relation to coastal features. Of the 102 students who had reached School Certificate level, twenty-two gained more than fifty percent of the marks and eighty less than fifty percent. Of the remaining sixty-two, twelve gained more than fifty percent and fifty less than half the marks. These results would suggest that geography, as taught in post-primary schools, does not improve knowledge of the 'place' geography of New Zealand, especially that appertaining to the island on the other side of Cook Strait.

Town	Percentage of Students locating Town:			Percentage making no attempt
	Within 25 miles	25 to 100 miles away	More than 100 miles away	
Whangarei	50	23	17	10
Thames	68	17	9	6
Tauranga	34	22	20	24
Hamilton	46	28	13	13
Taumarunui	16	25	20	39
Stratford	35	23	15	27
Hawera	34	30	10	26
Palmerston North ..	65	23	11	1
Hastings	46	25	13	16
Blenheim	66	27	4	3
Westport	67	26	6	1
Greymouth	60	32	6	2
Ashburton	68	30	2	—
Tuatapere	6	8	14	72

The second test dealt with Europe, students being asked to identify, on maps showing boundaries only, the twelve countries: U.S.S.R., Czechoslovakia, Greece, Netherlands, Hungary, Eire, Poland, Finland, Spain, Bulgaria, Denmark and Yugoslavia. Between 1947 and 1951 a total of 581 students were tested soon after entering the college. The average score was 9.2 correct, the men scoring higher than the women students in every year, and the overall score for 1951 being better than that of previous years. In 1947 and 1948 the test was also applied to 103 adults from a large factory, a W.E.A. class and a group of accountancy students. These averaged 8.5 correct—a higher score than that attained by ninety-six short-term training college students in 1950 and 1951.

Yet all these results compare favourably with a similar test carried out on adults in the United States. There college-trained people attained an average of seven, those who had been through high school averaged six, whilst those whose education had been confined only to grade school scored but three. In the test given at Christchurch the two countries most easily recognised were Spain and the U.S.S.R., and those least identified were Bulgaria and Hungary. Yet when one person in thirty does not know the location of Spain and one in ten does not recognise Greece, it is hardly surprising that Bulgaria and Hungary are confused and that more than half failed to identify them correctly.

This problem is not New Zealand's alone. The 'place' geography of students entering American universities shows even greater failings, as is shown by the comprehensive tests undertaken by the *New York Times* and published prominently in that journal in December 1950 and May 1951. Some results of these tests were also reported in the *Readers Digest* and in an article by B. Fine in the *Journal of Geography* (Vol. 50, No. 4, April 1951). Nevertheless New Zealanders cannot be complacent. The Waikato is not in Southland, nor is Hastings in North Auckland—as some students who took the University Entrance examination would like to believe. If this country aims at an effective democracy, it needs well-informed citizens—well-informed not only about their own country, but about the world at large. Examiners' reports on attainment in School Certificate have repeatedly pointed to this deplorable state of affairs. These reports should have wider publicity.—GEORGE GUY

GEOGRAPHERS IN THE UNIVERSITY. Mr. B. J. Garnier, Senior Lecturer in charge of the Department of Geography in the University of Otago, Dunedin, left in February 1951 to take up a new appointment as Professor of Geography in the University College of Nigeria at Ibadan. As the first secretary of the society he did much to bring it to its present secure position, and the good wishes of members will go with him in his new venture. At Otago the post of Head of the Department has been filled by the appointment of Mr. R. G. Lister, Lecturer in Geography at Auckland University College, and the staff has been augmented by the appointment of Miss Eileen Elliott, a graduate of the University of Cambridge, lately employed by the Ministry of Town and Country Planning in England.

From Canterbury University College Dr. D. J. Patton and Mr. Howard Critchfield, who had each served a two-year term as Visiting Lecturer, have returned to the United States. Dr. Patton has taken an appointment at the University of Maryland, and Mr. Critchfield is completing the residential requirements for his Ph.D. degree at the University of Washington at Seattle. The vacant post of Senior Lecturer has been filled by the appointment of Mr. L. L. Pownall, and Mr. Robert B. Lamb has come from the University of California at Los Angeles as Visiting Lecturer for two years. In February of last year Mr. A. J. Rose left to join the staff of the New England University College at Armidale, N.S.W., his post as Junior Lecturer being filled by the appointment of Miss June Chapman. The many friends of Mr. Graham Lawton, formerly Senior Lecturer at Canterbury University College and later Associate Professor in the University of Washington, learn with pleasure of his appointment to a Readership in Geography in the University of Adelaide. Two graduates of Canterbury University College have recently been appointed to university lectureships in England; Mr. W. P. Packard, Rhodes Scholar, going to University College, London, and Mr. J. S. Duncan, University Travelling Scholar, to the University of Manchester.

Mrs. Joyce Bewley resigned her post as Junior Lecturer at Victoria University College, Wellington, in 1950. Mr. S. H. Franklin, a graduate of the University of Birmingham, has taken up his appointment to this position.

At Auckland University College during 1951 Professor K. C. Edwards of the

University of Nottingham acted as Head of the Department of Geography while Professor K. B. Cumberland was absent on leave. Professor Cumberland served as Visiting Professor at the University of Wisconsin and returned to New Zealand by way of Great Britain. Professor Edwards has now returned to Nottingham and has been joined there by Mr. W. B. Johnston who formerly held the post of Junior Lecturer at Auckland. Mr. A. W. Smith returned to the United States at the end of 1950 on completion of his two years as Visiting Lecturer, and Mr. W. M. Brown was appointed Lecturer. Mr. B. H. Farrell also joined the staff as Junior Lecturer.—G. JOBBERNS

NEW TOPOGRAPHIC MAPS. In the *New Zealand Geographer,* Vol. VI, No. 2, October 1950, a note was made of additions to the N.Z.M.S. Series Nos. 1 and 2 on the scales of 1 : 63,360 and 1 : 25,000 respectively. Since then twelve new sheets have been published by the Department of Lands and Survey, ten on the smaller and two on the larger scale. These last two sheets, Martinborough (N. 161/9) and Lincoln (S. 83/6) conform with the high standard of cartographical reproduction already evident in recent issues on this scale. The Lincoln sheet portrays extremely well the major topographic characteristics of this part of the Canterbury Plains, and is distinguished, too, by the use of interpolated contours at 75 and 125 feet.

Three of the sheets on the scale of 1 : 63,360 are second editions replacing the previous provisional series—Burnham (S. 83), Akaroa (S. 94), and Amberley and Motunau (S. 68 and S. 69). In this reprinting the same plates have been used, with their unfortunate defects of coarse draughtsmanship; in fact the only changes discernible are small modifications in the supplementary marginal information and slight alterations in the tints of ink now that all maps are printed by the Government Printer. (These maps first appeared during the war and were the work of private printers.)

Five of the remaining maps have been published in conformity with the older provisional style—Houhora (N. 6), Coromandel (N. 40), Takaka (S. 8), Adele (S. 9), and Cobb (S. 13). Nevertheless they are classed as first editions, rather unfortunately since they hardly bear comparison with the new first edition sheets coming off the press. Auckland (N. 42) and Wellington (N. 164) are excellent reproductions, worthy of the work that has been put into them. Fine lines, skilled draughtsmanship, and well-chosen tinting combine to produce maps which possess both a utilitarian and an aesthetic appeal. The differentiation between bush and scrub by the use of two green tints represents a marked improvement over the provisional series, as does the inclusion of added information in the way of symbols. The Auckland sheet especially heralds a return to the prewar standard set with the Napier and Hastings sheet, and augurs well for future topographic maps published by the Department of Lands and Survey.

THESES IN GEOGRAPHY. Thirteen theses were presented in 1951 by students fulfilling the requirements for the degrees of M.A. or M.Sc. with Honours in the University of New Zealand. The popularity of 'town and region' studies was again demonstrated by the fact that six of the theses fell within this category. Four embraced studies in rural land utilisation, one of them dealing particularly with the modifications contingent upon nearby city growth. The remaining three theses were distinctive.

Historical and economic geography have hitherto received little attention from postgraduate students in this country, but present indications suggest that research in these fields can be competently handled by candidates for a master's degree. Likewise it is pleasing to record that the present-day Maori is deemed a subject worthy of geographical research at this level, for here is one of the 'problems' peculiar to New Zealand.

Theses were presented as follows:—

From Canterbury University College:
The Functions of Gore, O. H. Brown;
Ashburton County, Mona S. Cole;
Karamea, R. M. Stevens;
New Plymouth, D. H. Thurston.

From Auckland University College:
The Rural-Urban Fringe of Western Auckland, Lorna L. Baker;
Urban Tauranga, O. B. Carleton;
Export Hinterlands of the Ports of the North Island, Lilian M. Gracey;
The Maori Population of the Auckland Province, A. Joan Metge;
The Bay of Islands County, W. M. Moore;
The Functions of Hastings, Malwa M. Spraggon.

From the University of Otago:
The Agricultural Geography of South Canterbury, Ruth Coxhead;
Otago in 1871, Mary B. Kibblewhite;
Oamaru, J. U. Macaulay.

Copies of these theses are deposited in the respective college libraries.

IN OUR CONTEMPORARIES . . .

1. *In New Zealand Journals* . . .

AGRICULTURE IN WAITAKI COUNTY

FARMING IN NEW ZEALAND; WAITAKI COUNTY: A. H. Mouat, *New Zealand Journal of Agriculture,* Vol. 83, No. 5, November 1951, pp. 345-352, and *ibid.,* Vol. 83, No. 6, December 1951, pp. 453-462.

Based as it is upon detailed field investigation, this article is a notable assessment of agriculture in Waitaki County where there are more sheep and a higher acreage of cereals and green fodder crops than any other county in the Otago Land District.

The introductory section deals briefly with settlement, surface configuration and climate, and is followed by a description of soil types by J. D. Raeside. The fourteen soil types are grouped into those of the high country, foothills, downs and plains. In the concluding section Mr. Mouat uses this soil classification as a basis for his description and map of farming types. From the geographer's point of view this concise account would be more easily appreciated if both the soil-type and land-use maps had been published on a larger scale so as to permit the inclusion of more locality names, especially on the downs and plains.

Much of the geographic character of Waitaki County derives from the contrast between the large holdings, low carrying capacity, considerable pasture deterioration and soil erosion of the high country on the one hand and, on the other, the smaller farms, high stock ratio and absence of serious erosion on the coastal lowlands. In his survey of high-country runholdings, Mr. Mouat describes flock management and emphasises the effect on carrying capacity of a correct proportion of summer and winter country. Recent conservation measures deserve mention. Besides encouraging rabbit board activities, the Soil Conservation and Rivers Control Council is attempting to control tussock burning and has recently taken over the Tara Hills run near Omarama for use as an experimental station.

Reference is made to innovations in two lowland localities. On the stony plains soils south of the lower Waitaki River 'the experimental irrigation farm sponsored by the North Otago Progress League has shown that irrigation by the border-dike method can increase the carrying capacity from about one and a half to four sheep per acre for year-round grazing'. It would also eventually permit a more diversified farm economy.

The high fertility of the 'black tar' soils of the Waiareka Valley and Totara district has long been recognised by the consistently high crop yields, but it is only since 1942 that its value for market gardening has been fully appreciated. Market gardens now occupy over six hundred acres and produce the bulk of early and late season vegetables for southern markets.

The survey concludes with a review of trends in the various types of agriculture and forecasts that greater production will follow further development of sheep farming. A graph, showing areas in crops from 1915-1916 until 1948-1949, stresses the progressive decline in wheat acreage from the 1921-1922 peak of 38,700 acres to little more than 7000 acres in 1947-1948.

In addition to the two already mentioned, there are maps showing relief, mean annual rainfall and sheep distribution, and numerous illustrations. This informative article is a worthy continuation of the series, 'Farming in New Zealand'.

—J. U. Macaulay

2. *In Overseas Journals . . .*

A Raw Material Little Utilised

PHORMIUM TENAX—NEW ZEALAND'S NATIVE HARD FIBER: H. J. Critchfield, *Economic Botany*, Vol. 5, No. 2, April-June 1951, pp. 172-184.

NEW ZEALAND PHORMIUM FIBER: *idem.*, *Foreign Agriculture*, Vol. 14, No. 2, February 1950, pp. 41-43.

Mr. Critchfield in his two studies on phormium fibre has made a contribution of value to students of New Zealand geography. The second article considers the same essentials as the first but is stated in a brief and more popular manner.

Phormium tenax, native to New Zealand and Norfolk Island, is the only commercial hard fibre plant thriving in mid-latitudes. However, because of the small production, the fibre is unimportant in world economy. This is strange in view of the fact that the fibre will grow in many countries, in a large variety of soils, at altitudes from sea level to 4000 feet, and under rainfall conditions of from twenty to one hundred and fifty inches a year.

Commercial production began in the early nineteenth century and reached a peak in 1907 when 28,547 tons of fibre left the country, but since that date export ceased and production, with fluctuations, declined to 5400 tons in 1948-49. A large part of current production still comes from the plant in its wild state, but 'natural' areas have tended to decrease in size. Attempts to improve the fibre supply have taken the form of draining lowland swamps to provide more suitable habitats and the establishment of plantations. Three of these exist: in Southland (1000 acres), at Kaingaroa, and the government-owned Moutoa Estate (5000 acres of drained swampland and plantation) near Foxton. Major uses for the fibre are in the manufacture of woolpacks, matting, bindertwine and lashing. The fifty percent of production used for woolpacks supplies about a third of the million woolpacks required in New Zealand annually.

Some problems of the industry are: the long harvesting cycle (4-6 years) which deters investment, disease and damage by moths, the draining of flax swamps for other purposes, a need for improved processing, and the effects of past economic instability. Nevertheless, as Mr. Critchfield says, 'The establishment of the Moutoa plantation (and experimental station) near Foxton may well mark the beginning of a stabilised native hard fiber industry'.—B. H. Farrell

REVIEWS

Of Sheepmen and their Country

THE EARLY CANTERBURY RUNS. By L. G. D. Acland. Christchurch: Whitcombe and Tombs Ltd., 1951, pp. 427.

The publication of this handsome volume, printed by the Caxton Press, brings together Acland's records of the early occupation of Canterbury by sheepmen. His introductory statement containing a brief explanatory account of how the first settlers acquired their land has been elaborated a little by C. R. Straubel, and the whole work, including for the first time a glossary of station words with an introduction by Arnold Wall, has been edited by A. H. Johnstone. The book is a credit to printer, publisher and editor alike and a fitting monument to the author, who was busily collecting material right up to the time of his death in 1948. It is worthy of a better map, but the one included as an end paper shows reasonably clearly the general plan of subdivision of early Canterbury.

Acland's notes on the early runs and runholders first appeared in serial form in the Christchurch *Press* in the 1920's and aroused much local interest; the first volume, published in 1930, rapidly became a collector's item. A second series was published in 1940, and a new revised edition in 1946 (reviewed in the *New Zealand Geographer,* Vol. III, No. 1, April 1947). The present book brings all his notes together in one volume. The author was uncommonly well equipped to compile a record of this kind. Apprenticed early to sheep farming (he was a cadet on Mesopotamia in 1896), he took up a variety of commercial pursuits that led him to travel widely, and returned to runholding on his own account in his later life. Association with the late T. D. Burnett of South Canterbury seems to have given him the idea of putting on record the pattern of the earliest subdivision of the land in Canterbury and describing the life and times of the early runholders while there were yet a few living to give him some first-hand information.

The introductory chapter is of especial interest and value. Condensed into the space of barely a dozen pages is a clear and simple statement telling what manner of men were the early runholders, whence they came, how they acquired occupational rights to the land, and how they worked and developed their new properties. Here is a glimpse of the economic history of the first decades of settlement in Canterbury. 'On the whole runholding has not been much of a business in Canterbury. Some runholders have done well but I think more have lost money. Scab ruined a lot of them in the 'fifties. Before the scab was cleaned up speculators and settlers began buying the best parts of the runs. Bad times in the 'eighties ruined more runholders than scab had done, and rabbits became a pest before the bad times had begun to get better; and the severe snowstorms of 1862, 1867, 1878, 1887, 1888, 1895 (the worst of all), 1903, 1908, 1918, 1923 and 1939 each used up several years' profits of high country runholders. Besides, hardly one of the early squatters (except the "Shagroons") had any sheep-farming experience whatever. A few were natural sheep men who soon learnt their business, but the only thing that saved any of the others was that competent Scotch managers and shepherds were more plentiful in the old days than they have ever been since.'

The main body of the book is a collection of notes on each of the individual runs shown on the accompanying map. Here the author is at his best. In a style easy and conversational, and completely unpretentious, he talks about his own people. No orthodox academic historian could give this lively, homely, human picture of the life and times of these founders of Canterbury. For it every student of the evolution of the contemporary countryside is indebted to Acland. The book is a monument to his patient industry, and it is to be earnestly hoped that the publishers will not let it soon become a collector's item like the first edition of 1930.—G. JOBBERNS

SOME SPECIMENS FROM THE 'BUSH'

NEW ZEALAND TREES. By J. H. Matthews. Wellington: A. H. and A. W. Reed, 1951, pp. 92.

Kirk's *Forest Flora* (1899) with its engaging narrative and magnificent plates has been out of print for longer than most can remember. Messrs. A. H. and A. W. Reed are therefore to be heartily congratulated upon the production of a 'revised and abridged *Forest Flora*'. *New Zealand Trees* is a slim, elegant volume which would grace almost any bookshelf. One cannot feel, however, that the author, a distinguished gardener, has taken such pains with his contribution, nor been as much at home in his work, as printer and publishers.

Mr. Matthews has been able to deal in detail with less than forty species, perhaps a quarter of the total number of trees and tall shrubs in New Zealand. While this is in no way a reflection on the author's treatment of his subject, but is merely a tribute to the diversity and interest of our 'bush', it is clear that Mr. Matthews' primary problem was one of selection. Many must feel uneasy, to say the least, with his choice. According to the preface, 'all the principal genera are included'. Where are *Carpodetus* (a monotypic endemic, occurring throughout the length and breadth of the land), *Olearia, Nothopanax, Hedycarya, Litsaea, Dodonaea, Libocedrus, Suttonia, Plagianthus, Olea, Mida, Melicope, Brachyglottis, Schefflera,* and many more besides? The author, however, describes *Pomaderris apetala* (tainui) despite its being quite rare in nature; *Dracophyllum longifolium* (grass tree) which is ill-defined, sub-alpine and usually shrub-like; and *Myrtus bullata* (ramarama), although it is usually a shrub, and its family has been already represented thrice and much more strikingly. Even if more important genera be not considered, would not Mr. Matthews have done better to exclude his weaker generic representatives in favour of additional important species such as the tree-rata, miro and taraire?

'It [the book] is, in short, a guide to the common trees of the Dominion.' Are not the manuka or tea-tree (*Leptospermum scoparium*), the mapau (*Suttonia* (*Myrsine*) *australis*) and the kohuhu (*Pittosporum tenuifolium*) supremely common, if at best small, trees? Moreover, most beginners badly need expert assistance in distinguishing the mapau from the kohuhu or even one kind of tea-tree from the other. Indeed, the famous word 'tea-tree' will be sought in vain in the book. The omission, or virtual omission, of these plants, like that of *Meryta* and some others, is all the more difficult to comprehend in view of the author's understandable bias towards cultivated species.

Who could blame the novice who concluded from *New Zealand Trees* that the particular species described for, say, *Dracophyllum, Griselinia, Melicytus, Weinmannia* or *Pseudopanax* was the only one in New Zealand? Certain it is that other species of all these genera, and more, will be mistaken again and again for the chosen ones. Critical, concise notes on other common and important species could have been appended with little trouble.

Regretful as one is to say it, Mr. Matthews's book is as disappointing and misleading in its errors of commission as of omission. These are sometimes so serious as to give quite the wrong general impression of a plant, for example, the leaves of *Entelea* (which the reviewer has seen over three feet long) are described as smaller than those of *Griselinia lucida*, when the reverse is generally most decidedly true. To the reviewer the remarks about the leaves of the tarata are incomprehensible; and it would take many paragraphs to sort out the chaos that will be found under the heading *Sophora tetraptera* (kowhai). The really salient distinguishing features of plants are sometimes omitted. Critical terms are confusingly used, such as 'family of *Pittosporum*', or are improperly defined—'dioecious'—even in the glossary ('dioecious' again, 'alternate', 'hybrid' and 'stigma' among others). Many will regret that the nomenclature is far more out of date than that of the fourth edition of *Plants of New Zealand* (1940).

More justice might have been done to Kirk's beautiful and accurate plates if the author of *New Zealand Trees* had asked a trained botanist to cooperate with him.

—L. H. MILLENER

ALIENS—OR NEW ZEALANDERS?

FROM EUROPE TO NEW ZEALAND: An Account of Our Continental European Settlers. By R. A. Lochore. Wellington: A. H. and A. W. Reed, 1951, pp. 112.

IMMIGRATION INTO NEW ZEALAND. Dunedin: New Zealand Institute of International Affairs, 1950, pp. 22.

The first published work on the problem of European aliens who have settled in New Zealand, Dr. Lochore's account is of particular value, because, in addition to setting out the facts about the position of immigrants of various ethnic groups, the author attempts to analyse the reasons for the less satisfactory records of some nationalities—more particularly of the South Europeans. The chapters are packed with a wealth of information on a series of European ethnic groups, their historical origins, their reasons for emigration and the manner of their coming (in stray groups and families, in 'chains', or in organised parties), their present distribution in these islands, their occupations and potentialities, the success or otherwise of their adaptation to the New Zealand way of life, and their attitude towards New Zealand and native-born New Zealanders. Dr. Lochore cannot but impress by his balanced and honest examination of the failure of some immigrants up to the second and third generation to come to terms with their new social and economic environment. He stresses the responsibility of New Zealanders whose indifference, even hostility, has helped in some cases to perpetuate the existence of exclusive alien communities and in others to restrict immigrants to uncongenial occupations.

Certain of the author's conclusions are of vital importance both in the formulation of an immigration policy and in our dealings with present and future immigrants. Southern Europeans can, he asserts, become useful and loyal New Zealanders provided that they receive guidance from responsible authorities and goodwill from the New Zealand community. Social classes and occupations are more important than national groupings, and the younger our immigrants the better.

From Europe to New Zealand is notable for the literary skill with which it is written, and for the wit and forcefulness with which the main points are made. It is a book which New Zealanders ought to read, both for pleasure and for profit.

The shorter report by a study group of the Dunedin Branch of the New Zealand Institute of International Affairs is a timely summary of the past, present and future policy of New Zealand in regard to immigration. Its main contributions are an historical survey of immigration from the days of the New Zealand Company to the present, and a discussion of the arguments for an increased rate of immigration, namely, the need for more workers to exploit fully the economic resources of the country, the need for greater diversification of production and a larger home market, and the present acute shortage of labour. Also valuable are the short but succinct sections on the types of labour especially required, the economically desirable rate of immigration over the next few years, and the most desirable sources of immigrants.

The last of these sections touches upon problems covered in Dr. Lochore's book. The field covered is wider in that non-European sources are considered; but the discussion is necessarily summary and the arguments tend to be primarily economic, to the neglect of the social and psychological considerations emphasised by Dr. Lochore. Thus, 'the peoples of the Island Dependencies of New Zealand in the Pacific also form an obvious reservoir of labour' (p. 17). But experience of such immigration (which, as well as increasing the New Zealand population, would serve to diminish overpopulation in the islands) indicates the need for careful selection, orientation to the ways of New Zealanders, and social as well as vocational guidance and supervision after arrival in this country.

The main general conclusion is the need for consistent planning and supervision of migration from the stage of initial selection of migrants right through to the time when they become fully accultured to life in New Zealand. Furthermore, such planning and supervision must be carried out in the light of knowledge of the economic, social and psychological factors in the situation, to the study of which both of these works are notable contributions.—RALPH PIDDINGTON

SOCIAL ACCOUNTING FOR EVERYMAN

THE NEW ZEALAND ECONOMY: 1939-1951. Wellington: Government Printer, 1951, pp. 71.

In the proliferation of 'new approaches' in which most academic disciplines have shared during the last decade or so, economics has produced at least one worthy newcomer. It is 'social accounting', which weds statistics to an analysis of the forces shaping the economy as a whole. Starting from the central concept of national income, the social accountant can build up his picture in various ways. He may sum up outputs into a total of production, and arrive at total income from the production side. Or he may work from expenditure, consumption and saving to the same national dividend. Whatever his approach, his analyses will reveal, in passing, some of the forces which may be making for contraction or expansion of the national income.

Even this summary glimpse of social accounting may give a clue to its importance. It is not merely for the academic specialist. Anyone who can read a little and think a little can gain great benefit by a study of a simple set of social accounts—such as is contained in *The New Zealand Economy: 1939-1951*.

This is not a vague appeal to the kind of sentiment which asserts that 'education' and 'self-improvement', whether they concern ceramics, conchology or calculus, should be taken up by a dutiful reader to strengthen his intellectual muscles and moral fibres. People should read *The New Zealand Economy* because sober enlightenment about the working of the economy, its possibilities, achievements and limitations, is a necessary part of the democratic process. The aim of evolving an electorate which is literate and informed must be grimly pursued, and this White Paper is a great help in that pursuit.

Teachers, then, should bestir themselves and read this work, if they have not already done so. All senior secondary school pupils should be made to buy it and work from it. Good sales may produce the desirable end of an annual publication. It is cheap, set out clearly and simply; above all it is important, for it concerns our own pockets.—A. J. DANKS

CONSPECTUS OF THE PACIFIC

THE PACIFIC ISLANDS. By Douglas L. Oliver. Cambridge: Harvard University Press, 1951, pp. 313.

As Dr. Oliver states, during his residence in the islands of the Pacific he acquired 'a mass of information and prejudices'—and the reader will find both in this book, which is the product of a growing interest in the Pacific peoples, and of Dr. Oliver's experiences in Micronesia and Melanesia. Those who hoped for an anthropologist's description of the islanders and their various cultures will doubtless be disappointed, for these receive but meagre space. Yet this is tellingly utilised. In a few pithy pages the salient facts and theories of Australian, Micronesian and Polynesian origins and cultures are summarised, and if the longer account of Melanesia is less coherent, this reflects the author's research as well as the lack of homogeneity within the region.

As a former president of the Society of Applied Anthropology, Dr. Oliver realises that native cultures are only one factor; consequently the successive waves of alien penetration, exploitation and development receive adequate attention. The impact of whalers and planters, merchants and miners, blackbirders, missionaries and administrators is sketched with unusual detail and directness. Yet one feels that the author is emotionally identified with ancient cultures, and is not always objective (for instance in his critical attitude towards missionary endeavour), while too many historical inaccuracies have crept into the text.

This will be apparent to Australian and New Zealand readers. Too little distinction is made between generally well-intentioned government policy and the often sordid events along a perhaps uncontrollable frontier, where the darkest aspects are stressed by emphasis of omission. It is surprising, for instance, to read that the Maori wars of the 'sixties caused 'enormous casualties on both sides'. Though it is salutary to have one's faults exposed, New Zealanders may justly object to the loose designation of a relatively mild colour bar as a 'caste system', and will maintain that the future of the Maori depends not upon his ability to hold supposedly threatened lands but on the development of his considerable resources and on the avoidance of economic dependence.

Nevertheless, with the perspective of an eminent anthropologist, Dr. Oliver presents a clear picture of historical trends affecting both the Pacific as a whole and the individual island groups. Geographers and historians will find a surprising wealth of information on cultural and economic change. The book concludes with an analysis of the effects of the second world war and an attempt to gauge the islanders' prospects and the possibilities of Communist influence. The discussion of problems of culture-change is sober and realistic. Despite his sympathies, the author does not advise the preservation of an anthropologist's vested interest, the primitive cultures, but accepts change as inevitable. A policy of *laissez-faire* tempered by guidance is predicted.

These views are presented for a non-specialist audience in a lively style which is pleasingly free from jargon, though exaggerated phraseology is employed. And the author sometimes seems to prefer scoring points to writing objective history. Though geographers will regret the inadequacy of the few maps, they will be able to quarry much valuable information from this book, which contains, in barely three hundred pages, one of the most comprehensive accounts of Pacific peoples and their changing cultures that has yet appeared.—G. LEWTHWAITE

THE PROGRESS OF GEOGRAPHIC THOUGHT

GEOGRAPHY IN THE TWENTIETH CENTURY. Edited by Griffith Taylor. London: Methuen and Co. Ltd., 1951, pp. 630.

THE SPIRIT AND PURPOSE OF GEOGRAPHY. By S. W. Wooldridge and W. G. East. London: Hutchinson, 1951, pp. 176.

Geography in the Twentieth Century is a series of essays by some twenty geographers to illustrate the 'growth, fields, techniques, aims and trends of geography' in the last fifty years. Only in the first section of the book, however, is this objective approached, and even here there are notable omissions. Following an introductory chapter of developments in the nineteenth century, the remaining four essays of Part I deal specifically with the evolution of geography and its philosophical basis in the present century. The French, German and West Slav schools of geography are fully discussed, but any attempt to assess Anglo-American geographic thought is replaced by Tatham's very full account of the differing concepts of environmental determinism and possibilism. The omission, and indeed the remainder of the book, is a fitting commentary on the lack of unanimity which has characterised Anglo-American geography in the twentieth century. Even allowing for a general acceptance of the concept of areal differentiation, the wide range of interests of British and American geographers make any objective assessment difficult, although an independent attempt by a French or German geographer might have been tried.

The book contains a further twenty essays on aspects of geographical study by writers recognised as authorities in their own field. Thus Isaiah Bowman contributes a chapter on modern pioneer settlement, and S. W. Wooldridge an essay on the progress of geomorphology. But there is very little here that is new material. Griffith Taylor's chapter on 'Urban Geography' is primarily a condensation of his book of the same title, and, with the notable exception of a review of 'Social Geography' by J. W. Watson, there is very little attempt by any of the authors to relate progress in their respective fields to the field of geography as a whole. The result is a lack of balance in the book. For whereas the early chapters on the French and German schools attempt such an assessment, there is no parallel summing up of the achievements of Anglo-American geographers. This, presumably, is a task for the reader, but the failure to discuss some aspects of the subject makes this difficult. Where, for example, is the essay showing progress in the field of economic geography? Geography may be 'what geographers do', as one author maintains, but surely geography in the modern English-speaking world is something more than an assortment of what these twenty geographers do? E. W. Gilbert writes a chapter on the administrative importance of regionalism in the modern world, but there is no attempt to discuss objectively the progress and concepts of regional geography.

In the range of topics covered, this book illustrates best the wide variety and rapid progress of geographic research in the present century. It shows, too, that the schism in Anglo-American geography is not yet completely healed. The editor is to be commended on his choice of contributors and the tolerance he shows to views which are contrary to his own, for it is in such academic tolerance that the hope of the world lies. Its illustration here possibly justifies the inclusion of the final chapter and the term *geopacifics*—the contribution the geographer can, or should, make to world peace.

Geography in the Twentieth Century will have a more limited value to students of the history of the subject than the title might at first suggest. Systematists, however, will welcome the summaries by recognised authorities on the progress and the problems characteristic of particular fields. It is doubtful if the history and scope of the subject can be written by a large committee of experts as is found here. Possibly more can be achieved by the individual who attempts an objective analysis.

Such a study is made jointly by Professors Wooldridge and East of the University of London. Their little book is a summary of the concepts of geography as held by what might be termed the London school. That the opinions expressed here differ from those of an American school may be seen from a comparison of *The Spirit and Purpose of Geography* and Hartshorne's monograph on the nature of the subject. The differences, however, are detailed rather than fundamental. The first two chapters of *The Spirit and Purpose of Geography* are a concise and very readable summary of most of the conclusions already drawn by Hartshorne. Here the history of modern geographic thought is lucidly traced and the chorological viewpoint of geography upheld.

The following chapters reviewing the branches of geography contain more points of difference. The plea for a genetic approach to the study of the physical elements of geography will draw more support from British geographers than from the disciples of Hartshorne. More disputable, however, are the statements on historical geography, which is here considered to be a systematic study concerned with the understanding of the processes recorded in human history which have fashioned the human geography of areas. It is difficult to follow the authors' reasoning in giving separate recognition to these processes on the human side but including them in their appropriate systematic studies in physical geography. More logical, and perhaps more representative of contemporary British thought is the recognition of historical geography as the geography of a past period, that is, as a particular form of regional geography. The reader, too, may wonder at the enthusiastic support for political geography on the one hand, and the desire to submerge economic geography in regional geography on the other.

It is in the concluding section on regionalism that the twentieth-century British attitude to the subject is best expressed. After cautioning the reader against the pitfalls in the too enthusiastic acceptance of a regional division based on the spheres of city influence, the authors give preference to a landscape division based on the physical elements. Although the concept of 'site' suggested here is relatively new, the ideas of a natural region date back to Herbertson. No doubt because of their declared attitude to economic geography, the authors make no attempt to explore the possibility of the contribution of agriculture to regional unity. The application of their ideas in southern New Zealand would allow of the delimitation of the southern boundary of the Canterbury Plains at Timaru. The southward extension of mixed farming, masking the change from downland to plain, however, justifies the enlarging of the geographic region to include an area as far south as Oamaru.

The Spirit and Purpose of Geography undoubtedly succeeds in its declared aim of 'signposting a path' for the student of geography but the absence of footnote references is a deficiency that is not fully overcome by the abridged bibliography. It is a book that will be essential reading for all students of the contemporary development of British geography.—A. D. Tweedie

The World Encompassed

THE OXFORD ATLAS. Edited by Brigadier Sir Clinton Lewis and Colonel J. D. Campbell. Oxford: Oxford University Press, 1951, pp. 212.

The publication of a new atlas is something that geographers look forward to, particularly when the event has been widely publicised. For it is a melancholy fact that no atlas is ideal; it must by its very nature be a compromise, particularly as regards coverage and costs. Accordingly, when the Oxford University Press announced their atlas with so much advertisement geographers confidently expected a publication which would bear all the impeccable hallmarks of an Oxford book and which would go a long way to meeting deficiencies in other atlases. But they were disappointed. The work of five years has been largely in vain.

Probably the most commendable features are the method of relief representation, the fineness of the printing—generally speaking, the adoption throughout the atlas of scales which are multiples of 1 : 1,000,000, and the attempt to secure as great a coverage as possible on each sheet. In this last respect the use of the 'Oxford' projection is ingenious and noteworthy, for otherwise it has no advantage over the interrupted projections already in vogue. Six-colour printing has contributed much of the efficiency of the 'layering' to represent relief, and the result is the nearest approach yet by British publishers to the excellent productions of German and Swiss cartographers. The greatest fault in the printing lies in the use of block capitals which are too thick and clumsy, especially on maps whose scale is 1 : 4,000,000.

With the arrangement of the maps themselves there can be no real quibble, since any combination of countries and areas is bound to cause particular comment sooner or later—in the reviewer's case, the corner location of the only worthwhile map of New Zealand, and that rendered all the more objectionable by a disturbing break where the pages join. (There are no such breaks according to the publishers' brochure.) One might question too the value of the two maps of air routes, and why South America is dismissed summarily in two maps. Surely Brazil at least is as important as Argentina. In similar vein the geographer would probably suggest that most of the maps I-XXIV are redundant since he has access to the original material, whilst the layman would no doubt prefer to see them replaced by other maps—of Brazil, for example. Another fault is the use of a red overlay for boundaries. Untidy maps result, and on some sheets boundaries and roads are hardly distinguishable at a glance. The black broken lines are sufficient, not only for the sake of clarity but also to make for consistency. Scale alone must explain why boundaries of English counties are so overprinted and those of French *départements* are not.

Yet the New Zealander, already disappointed in the space allocated to his country, will find even more serious blemishes. There are no such rivers as the Waikatoo, Waian or Wangantoi. The railway between Taneatua and Opotiki does not exist, and the former timber line to Mokai can never be put in the same category as the North Island Main Trunk. Havelock and Greytown are incorrectly located. Several other misspellings are present and have been noted in the corrigenda. Admittedly mistakes can occur, even in Oxford books, and one cannot condemn an atlas because of obvious faults on one map. But that of New Zealand does not stand alone in this respect, and it can be argued that if such mistakes were made in the draughting of a map of a British dominion for a British atlas, how much more inaccurate are likely to be maps of areas for which topographic details are less readily available.

Briefly, then, *The Oxford Atlas* could have been a first-rate publication. That it is not is a matter for great regret. Beyond a compendious index-gazetteer it contributes little new as a work of reference, and, despite the publishers' claims, it cannot take its place beside the Oxford dictionaries.

Brave New World

WORLD RESOURCES AND INDUSTRIES. By Erich W. Zimmermann. New York: Harper and Brothers, 1951, pp. 832.

The first edition of this monumental work appeared in 1933, presenting an analysis of the relation between human society and the material resources on which it rests that must have been a mine of information and stimulating ideas for geographers, economists and social historians alike. Since then the world has passed through the years of depression and world war into the age of atomic energy. This new edition brings one right up to date. In a brief review it is impossible to give an adequate account of the scope of this vast work. The general plan remains that of the old edition, but new maps, statistical diagrams and some excellent photographs make this book easy and fascinating to read. Of special interest to this reviewer are the two final chapters on the closely related topics of 'Conservation' and 'Resource Adequacy'.

'The pessimists of today base their predictions on two main arguments: soils are being depleted because of erosion and overcropping, and people are multiplying too fast. Actually the issues involved are much broader. For one thing, the problem of the future supply of inanimate energy may embrace all other issues within itself. If, by the time the present sources of most of the inanimate energy used today—the fossil fuels—are exhausted, nuclear energy and other new forms of inanimate energy have not been developed so that they can provide for the vastly enlarged needs of the future era, civilisation as it is now known will come to an end anyway, regardless of the prevailing status of soil fertility, hydrologic cycle, and similar factors determining the food supply. In the world today, transportation is a prime necessity and in the absence of inanimate energy it will deteriorate to the point of virtual uselessness.

'The problem of resource adequacy is also one of social institutions, of government policies, and of international relations. If the preceding discussion has led to any vital conclusion, it is the 'altogetherness' of things. In this inextricable mesh of forces and conditions man appears as the responsible agent. The problem of resource adequacy for ages to come will involve human wisdom more than limits set by nature'.

Thus, in so many words, ends a remarkable book that is indispensable to any serious student of geography, economics or social history.—G. Jobberns

A Cultural Viewpoint

CULTURE WORLDS. By R. J. Russell and E. Kniffen. New York: The Macmillan Company, 1951, pp. 620.

In a foreword to this stimulating and provocative book the authors explain how, in the Louisiana State University, they embarked on an experiment—'the expansion of the regional course to a full year as an introduction to geography at the freshman level, with a shifting of the elements course to the sophomore year. The success of the plan was amazing. From being a subject barely open as an elective to a limited number of students, geography soon became a prescribed course in practically every curriculum in the university. Enrolments in the elements course soon exceeded those of the years when it was offered as the first course in geography'.

One of the authors, Russell, has a major interest in geology with a special bent to geomorphology, the other, Kniffen, has given a lead in various fields of cultural geography. Both are former students and acknowledged disciples of Carl Sauer. Together they show the way to the use of geography in the wider field of general education of the university student. This is the most remarkable feature of the book.

A quite unpretentious survey of the general descriptive geography of the world, its novelty lies wholly in the method of organisation of the material presented, and it is easy to understand its appeal to university students as giving them background knowledge of the world in which they will all have to make their way.

For the presentation of a general account of the geography of the world, seven 'culture worlds' are distinguished and the material is so organised as to bring out the contrasts in character of these, and to give some account of the evolution of the contemporary cultural landscape in each. 'Individual societies of people possess characteristic culture traits that enable social scientists to group peoples according to the cultures. The broadest of these groupings are culture worlds. Seven of them are so distinctive that they form an excellent basis for introducing students to the field of regional geography. These broadest subdivisions of the earth are the European, Dry, African, Oriental, Polar, Pacific and American worlds. . . . Each has subordinate realms and regions. Culture worlds have differentiated gradually, each as a result of long and complicated series of events and experiences. Contrasts among them have arisen mainly because of isolation. Within the last few centuries the European World has undergone amazing expansion, a movement recognised as the New World Revolution. European peoples and cultures have advanced into other culture worlds with marked success in many instances, indifferently in others, and with failure in some.'

This is an impressive book. Whether or not it becomes widely accepted in the universities as an introduction to advanced courses in geography, there can be no question of its value as a demonstration of what a course in geography could contribute to the general education of the university student, whatever be the special field of his study.—G. JOBBERNS

POPULATION FACTS AND FIGURES

DEMOGRAPHIC YEARBOOK 1949-1950. New York: United Nations, 1951, pp. 558.

This is the second issue of a yearbook which has already proved its worth, and it is not surprising to find that this volume has a wider coverage than its predecessor. In a world where the population is increasing at the rate of one percent every year, demographic problems are of a prime order, not only in themselves, but also in the related spheres of food supply and standard of living. Indeed the implications are wider in these unhappy days of power politics.

The data presented in this yearbook are based upon statistics from every country of the world which makes them available, and cover such aspects as births, marriages and deaths, population densities, rates of growth, occupations, and international migration. These occupy 400 pages of tables. The remaining pages are filled with notes, discussions, evaluations and explanations—necessary details when statistics are culled from various sources and their validity, comparability and basic criteria may be questioned.

In short the *Demographic Yearbook 1949-1950* is indispensable to all those people who are interested in the populations of the world, be they geographers, economists, business executives, or just intelligent citizens seeking up-to-date information.

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The New Zealand Geographical Society was founded officially in Wellington towards the end of 1944. Its real foundation, however, took place in Christchurch in 1939 when a group of enthusiasts formed what is now the Canterbury Branch of the Society. Their lead was followed in February 1944 in Wellington, and further branches came into being in Auckland and Dunedin early in 1945.

The aims of the Society as stated in the constitution are 'to promote and stimulate the study of geography'. These are the aims of more than one Society in the world and the New Zealand Geographical Society is particularly concerned with geography in New Zealand. It is therefore the Society's policy to stimulate geographic studies of New Zealand and matters closely related to the Dominion.

The Society undertakes the publication of a journal, the *New Zealand Geographer*, and of a *Record* of its proceedings, both of which at present appear twice a year. Branches of the Society organise lectures, study groups, and excursions, and encourage their members to prepare matter for publication in the *New Zealand Geographer*. Contributions from overseas writers and those who are not members of the Society are also encouraged.

Membership of the Society is open to all persons interested in the aims of the Society. Full details of membership will be sent on request by the Secretary, New Zealand Geographical Society, Department of Geography, Canterbury University College, Christchurch, C.1.

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